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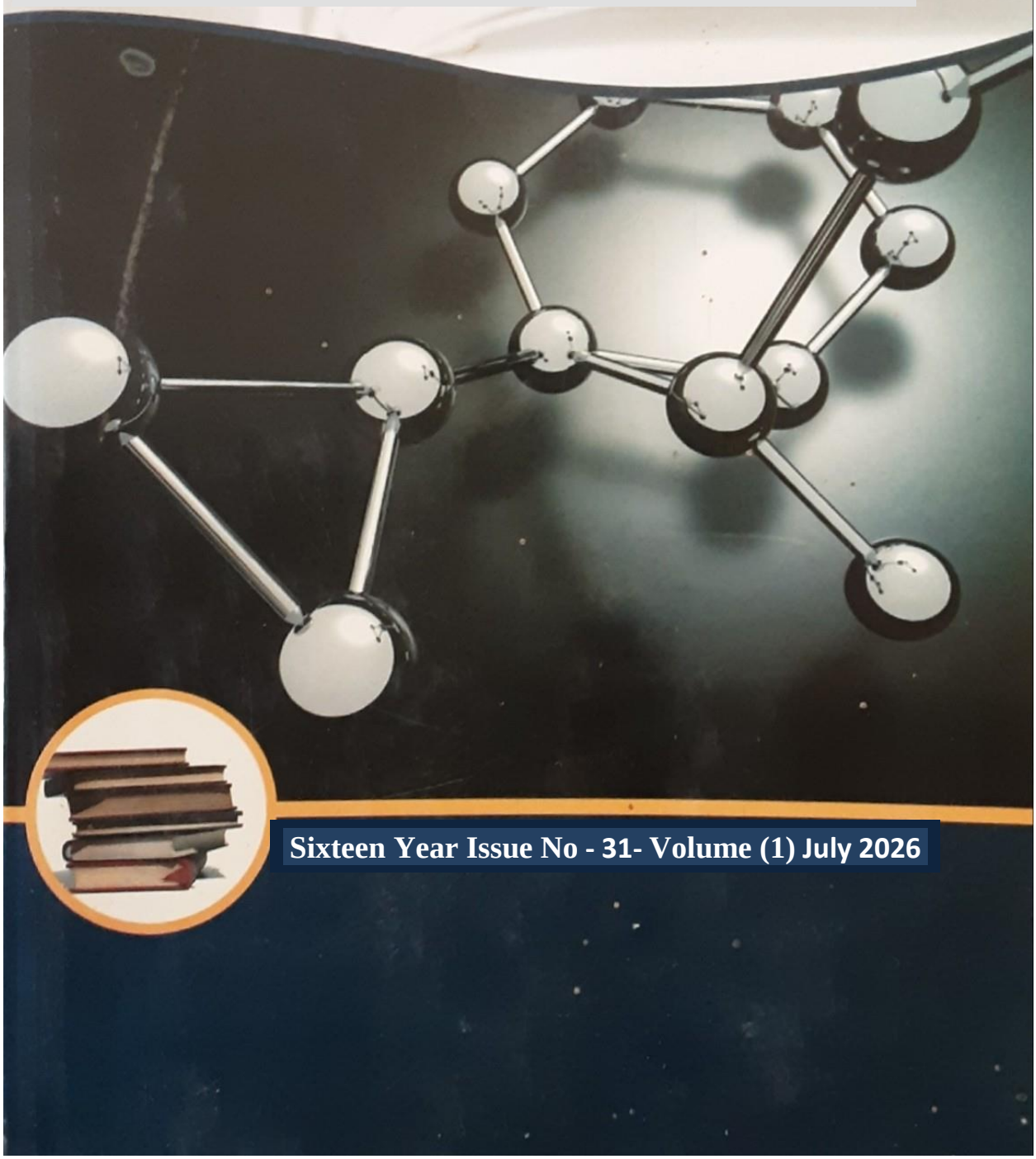
University of Dongola

Journal Of Scientific Research

Periodical Peer Reviewed Research Journal Issued by the College of Graduate Studies, University of Dongola



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University of Dongola

Journal of Scientific Research

Periodical Peer Reviewed Scientific Journal

Issued by the college of Graduate studies

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Journal of Scientific Research

Biannual Peer Reviewed Scientific Journal

Issued by the college of Graduate studies

Dongola, Sudan

Introduction:

The Dongola University Journal of Scientific Research is a semi-annual peer-reviewed scientific journal published by the College of Graduate Studies at Dongola University. It contributes to expanding the scope of science and knowledge by publishing original, methodologically sound, and scientifically valuable research papers. In line with this vision, the journal welcomes contributions from professors and researchers both within and outside the university, provided their work meets all the fundamental requirements of scientific research and has not been previously published or is currently under review for publication in any other journal.

Publication Guidelines:

- The journal accepts research papers in triplicate, printed on one side of A4 paper with double spacing and 2.5 cm margins. The paper should not exceed forty pages, including abstracts, the main body, references, and appendices. The font size should be 14, and the pages should be numbered sequentially at the bottom left.

- The research paper must include an abstract of approximately ten lines in the original language (Arabic or English). In addition to a comprehensive abstract in English if the research is written in Arabic, and a comprehensive abstract in Arabic if the research is written in English.

- The research paper should begin with the following: title, researcher's name, department, college, university, city, country, and keywords in both Arabic and English.

- The research paper must adhere to the best scientific practices in its presentation, including the abstract, research methods and tools, presentation and analysis of the topic, findings, recommendations, and bibliography, all according to the established methodology.

- Tables, figures, diagrams, and photographs drawn in black ink must be numbered and clearly labeled for easy reproduction.

- Submitted research papers are subject to peer review by specialists in the field**.**
- For research papers and extracts, the grade awarded, the date of submission, the university to which it was submitted, and the evaluating committee must be clearly stated.
- After review, the researcher is required to submit the research on a CD.
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- Researchers are requested to attach their curriculum vitae.
- Authors whose research is published in the journal are entitled to two copies of the relevant issue.
- The journal is not obligated to return papers that are not accepted for publication and will send a notification of non-publication to the author. Papers should be sent to the journal at the following address:

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Editorial:

It is with great pleasure that I present to you the thirty-first issue of the Dongola University Journal of Scientific Research. We hope that it has quenched the thirst of many researchers and publishers who have been waiting for their research to see the light of day. The editorial board emphasizes that this delay is beyond its control, and it strives to satisfy all publishers across various scientific disciplines.

To facilitate access for all publishers and those wishing to receive a copy of the journal or their research, they can visit the Dongola University website or the Dongola University repository to easily download their papers. These papers include the journal's cover, the editorial board, the editorial advisors, and the publishers' index.

In conclusion, we look forward to seeing you in a new and updated issue of the Dongola University Journal of Scientific Research. We reiterate our invitation to all faculty members and those interested in education and scientific research to contact us via the journal's phone numbers and email.

May God's peace and blessings be upon you.

Editor-in-Chief

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Facies, Facies Architecture and Depositional Environments of Merkhiyat Member, Omdurman Formation, around Khartoum, Sudan

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Abstract:

The study has been carried out on the Albian – Early Tournian Omdurman Formation in northern peripheries of Khartoum Basin. Lithologically, Omdurman Formation is divided into Merkhiyat and Umm Badda Members. The study aims to analyze the lithological facies and construct facies architecture to determine the depositional environment of Merkhiyat Member, Omdurman Formation.

Detailed facies analysis based on vertical and lateral profiles has revealed nine facies, and these are: matrix – supported massive pebble conglomerate facies (Gms), trough cross – stratified pebble conglomerate facies (Gt), planar cross – stratified pebble conglomerate facies (Gp), trough cross – stratified sandstone facies (St), planar cross – stratified sandstone facies (Sp), horizontally stratified sandstone facies (Sh), laminated siltstone facies (Fl) and massive mudstone facies (Fm).

Six architectural elements are differentiated within Merkhiyat Member. The proximal and medial alluvial plains are characterized by gravelly and sandy channel elements (CHg and CHs) and sandy bedform (SB). Overbank deposits included proximal and distal flood plain elements (FFB and FFD), crevasse splay element (CS) and levee deposits (LV).

Surfaces lithofacies analysis shows that Merkhiyat Member is composed of coarse – grained facies deposited by low sinuosity braided streams characterized by shallow channels, bars, and uncohesive banks. This member shows fining upward sequences of vertically stacked channel and bar deposits.

The depositional model of Merkhiyat Member can be represented by finning upward sequences reflecting allogeneic and autogenic controls on sedimentation. Base level change is controlled by gradual decrease of tectonic activity leading eventually to the dominance of an open or external drainage system during the deposition of the Merkhiyat Member.

Key Words: Merkhiyat Members, facies, architectural elements, allogeneic and autogenic controls

مستخلص:

تناول البحث دراسة أنواع السحنات ، معمارية السحنات و البيئات الترسيبيه لعضو المرخيات متكون أمدرمان الطباشيري الأعلي حول ولاية الخرطوم. صخرياً قُسم متكون أمدرمان الي عضوي أمبدة الأسفل والمرخيات الأعلي. تهدف الدراسة الي تحليل السحنات الصخرية وبناء معمارية السحنات لتحديد البيئة الترسيبيه لعضو المرخيات متكون أمدرمان.

أشار تحليل السحنات الصخري الي إحتواء متكون أمدرمان علي سحن الكونجلومرات المصمت والمتطبق المتقاطع المقعر والمستوي. سحن الحجر الرملي ذو التطبق المتقاطع المقعر والمستوي والأفقي، سحنة الحجر الرملي ذو التطبق المتقاطع المتموج، سحنة الغرين المترقق وسحنة الطين المصمت.

تم تمييز ستة عناصر معمارية تحتوي علي عنصري القنوات الرملية والحصوية، عنصر الأجسام الرملية، عنصري السهول الفيضية القريبية والبعيدة، عنصر رواسب شق النهر وعنصر رواسب الشرفات الطبيعية.

أفضي تحليل السحنات الصخرية السطحية بأن عضو المرخيات يتكون من تتابعات سحنة ناعمة لأعلي من رواسب قنوات وجزر متراكبة رأسياً وتشيع فيه السحنات الخشنة وقليل من السحنات الناعمة من الغرين والطين ترسبت بواسطة أنهار متشعبة قليلة التعرج تتميز بقنوات ضحلة ،جزر وضفاف غير متماسكة.

النموذج السحني لعضو المرخيات، متكون أمدرمان يتكون من تتابعات سحنية ناعمة لأعلي تُظهر تحكم عوامل داخلية وأخري خارجية، حيث أن تغيُر مستوي القاعدة مرتبط إرتباطاً وثيقاً بالتناقص التدريجي للنشاط التكتوني الذي أدي أخيراً الي شيوع نظام تصريف مفتوح أو خارجي خلال فترة ترسيب عضو المرخيات.

الكلمات المفتاحية: عضو المرخيات، السحنات، العناصر المعمارية، الضوابط الخارجية والذاتية

Introduction:

The study area is bounded by latitudes 15° - 16° 20′ N and longitudes 32° - 33° E. Omdurman area is particularly considered in more detail in this study (Figure 1). The study aimed to investigate facies types, architecture and depositional environments of the clastic sediments around Khartoum area.

Many authors published papers related to the same topic these are: Kheiralla (1966), Whiteman (1971), Omer (1975), Husein (1976), Prasad *et al.* (1986), Barazi (1989) , Klitzsch *et al.* (1984& 1990), Wycisk (1990), Schrank and Awad (1990), Bireir (1993), Awad (1993&1994), Bussert (1993), Farah (1994) and Eisawi (1999).

Figure 1 location map for the study area.

Regional Geology and Tectonic Setting:

In general, the whole Khartoum region is covered by Nubian sandstone, superficial deposits and gravels except in the south and north of Khartoum area where there are some Tertiary basaltic dykes and Basement Complex outcrops. Most of the Nubian sandstone outcrops are on the western side of the Nile.

The geology of the studied area can be subdivided into (4) main units of increasing age and these are: Superficial deposits, Tertiary basalt, Nubian sandstone Formation and Basement Complex (Figure 2).

Khartoum Basin:

Khartoum Basin is lithostratigraphic term for late Jurassic to Tertiary formations in some several sub basins, aligned SE–NW, bordered to the north by the Sabaloka Basement Complex and to the south by the faulted basement block north of Sennar and El Duaim (Omer 1983). Awad (1994) described these formations based on material from Al Democratia -1 borehole the type section for these formations which include Azaza, Abu Gin, Sawagir, Hebika, Mansur, Omdurman, Esari and Gezira Formations (Table 1).

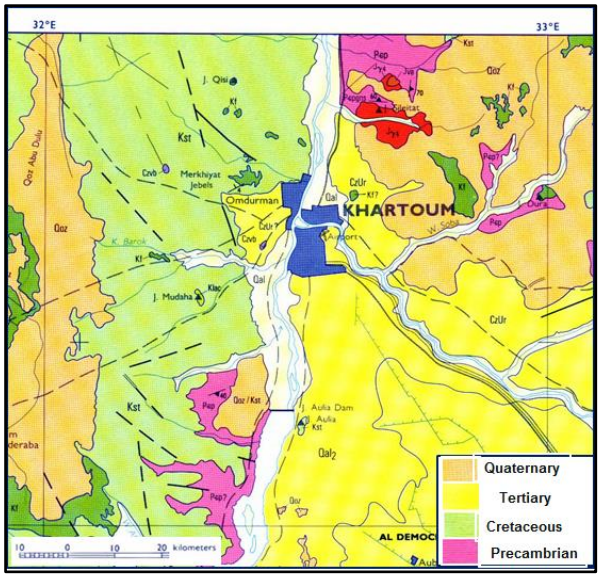


Figure 2 geological map of the study area after GRAS (1988).

Omdurman Formation:

The term is introduced by Whiteman (1970) for lithostratigraphic fluvial cross-bedded sandstone intercalated with kaolinitic fine grained sediments near Omdurman city. Its type locality section Jebel Merkhiyat is a few kilometres west of Omdurman. Bireir (1993) subdivided Omdurman Formation into upper (outcropping sediments) and lower Omdurman Formation (subsurface strata); where Awad (1994) renamed them as Merkhiyat Member and Umm Badda Member respectively.

Merkhiyat Member:

Merkhiyat Member locally unconformably overlies the Basement rocks and is composed of incomplete fining upward sequences of vertically stacked channels of poorly to moderately sorted, medium to coarse grained, trough and planer cross-bedded sandstone, characterized by scattered mud clasts as a basal lag; these sediments were deposited in braid plain environment, perhaps in distal reaches of an alluvial fan (Bireir, 1993; Barazi, 1989 and Awad, 1994).

Umm Badda Member:

late Albian to Cenomanian age unit known mainly from the subsurface and is composed mostly of moderately sorted fine grained sandstone, siltstone and subordinate claystone and shales shows very rapid lateral changes of facies, these sediments were deposits in meandering streams with well-developed overbank sedimentation and / or deposits of small ponds and shallow lakes (Awad and Schrank 1990; Awad, 1994; Bireir, 1993 and Farah, 1994).

Table 1 stratigraphic column of the central Sudan

<table>
<tr><th colspan="4">Geological Unit</th><th>Age</th><th>Reference</th></tr>
<tr><td colspan="4">Windblown sand & superficial deposits</td><td>Quaternary</td><td>Vail(1988)</td></tr>
<tr><td colspan="2" rowspan="2">Gezira Formation</td><td colspan="2">Mungata Member</td><td rowspan="2">Olig-Miocecne
Paleocene</td><td rowspan="2">Awad(1994)</td></tr>
<tr><td colspan="2">Wad Medani Member</td></tr>
<tr><td colspan="4">Tertiary Volcanic Rocks</td><td>Early Tertiary</td><td>Vail(1988)</td></tr>
<tr><td colspan="4">Esari Formation</td><td>Campanian -
Mastrichtian</td><td>Sun Oil Company (1989 unpublished rep) & Awad (1994)</td></tr>
<tr><td rowspan="2">Mansur Formation</td><td rowspan="2">Omdurman Formation</td><td>Merkhiyat Member</td><td></td><td>Senonian</td><td rowspan="2">Shrank &Awad (1990)
Awad (1994)
&Eisawi(1999)*</td></tr>
<tr><td>UmmBadda Member</td><td></td><td>Albian – Cenom/Early Turonian</td></tr>
<tr><td colspan="4">Hebeika Formation</td><td>Early Barremian</td><td rowspan="4">Sun Oil Company (1989 unpublished rep) & Awad (1994)</td></tr>
<tr><td colspan="4">Swagir Formation</td><td>Neocomian</td></tr>
<tr><td colspan="4">Abu Gin Formation</td><td>Early Neocomian</td></tr>
<tr><td colspan="4">Azaza Formation</td><td>Late Jurassic</td></tr>
<tr><td colspan="4">Post Orogenic Igneous Formation</td><td>Middle- Late Paleozoic</td><td>Vail(1988)</td></tr>
<tr><td colspan="4">Basement Complex</td><td>Silurian (K-Ar dating)</td><td>Sun Oil Company (1989 unpublished rep)</td></tr>
</table>

Methods of Investigation:

Twelve outcrops and a number of shallow excavations around the north Khartoum Basin were systematically examined using vertical and lateral profile methods. The examination involved detailed descriptions of sediment composition, grain size, colour, weathered surfaces, sorting, sedimentary structures, paleo-current direction and fossil content. Vertical profiles were examined through many facies aspects measurements and photographed, providing data for stratigraphic classification into recurrent facies. For facies classification, the terminology and conceptual framework of Miall (1978a, 1982, 1996), Feng (2019), Elatrash *et al*. (2021), Leila *et al.* (2022), and Mou (2022) were adopted. Each vertical profile was photographed, measured, and examined in detail, with subsequent subdivision into facies based on primary sedimentary structures, lithology, texture, and composition.

Facies Description of the Vertical profiles:

Lithofacies analysis of the twelve vertical profiles revealed nine distinct facies (see Table 2 and Figure 3). These facies were classified based on sedimentary structures, grain size, sorting, and lithology.

Table 2 presents the thickness and distribution of these facies across different locations, expressed in meters, with percentage contributions to the total section.

Location / Facies	Qisi	Merkhiyat	Abuwillidat	Azrag	Merkhiyat West Kaolin	Merkhiyat East Kaolin	Mudaha	Mundara	Aulia	Kabbashi	Rauwiyan	Elsheikh Eltayeb	Total	Percentage
Gm	0.5	0.3	0.8	0.3	-	-	0.8	2	0.2	1	2	5	17.9	**4.8**
Gt	-	-	4.5	-	-	-	-	--	1	-	1	-	6.5	**2.4**
Gp	-	-	-	1	-	-	-	-	-	-	-	-	1	**0.4**
St	58	12	12	20	-	-	12	16	15	36	35	12	22.8	**84.4**
Sp	-	3	0.5	-	-	-	0.25	-	-	-	-	-	4.25	**1.6**
Sr	-	-	-	-	0.25	4.5	-	-	0.9	-	-	-	1.15	**0.4**
Fl	0.5	-	0.5	-	4.75	4.5	-	-	3.5	0.5	-	0.3	14.55	**5.4**
Fm	-	0.03	-	0.75	0.25	0.5	-	-	1.2	0.1	-	0.1	2.9	**1.1**
Total	59	15.33	18.3	22.05	5	5	13.55	18	20.9	37.6	38	17.4	270.13	
Gravel %	0.85	1.9	28.9	5.8	0.00	0.00	5.9	11.11	5.7	2.7	7.9	28.7		

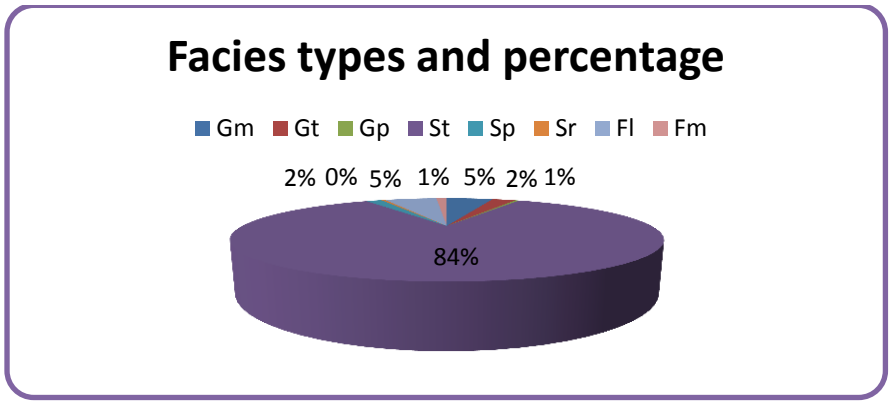


Figure 3 illustrates the relative abundance of facies types within the profiles.

1. Matrix-Supported Massive Conglomerate Facies (Gm):

Composed mainly of quartz pebbles with minor mud clasts and igneous lithics. Clasts are angular to subrounded, poorly sorted, supported by a matrix of sand, silt, and mud. Imbrication is generally absent, but some tabular clasts may be horizontally oriented (see Plate 1, Photo 1). The average thickness is approximately 12.9 m, accounting for 4.8% of the total studied area. This facies indicates low-energy, braided stream deposits, featuring lag deposits with scattered mud clasts and longitudinal bars.

2. Trough Cross-Bedded Conglomerate Facies (Gt):

Characterized by broad, scoop-shaped bodies that cut laterally and vertically. Composed mainly of angular to subangular pebbles (1–10 cm) supported by poorly sorted sand, silt, and clay

matrices. Thickness varies from 1 to 4.5 meters across profiles (see Plate 1, Photo 2). These deposits suggest high-energy, shallow braided channels.

3. Planar Cross – Bedded Conglomerate Facies (Gp).

Composed mainly of 1.5 mm – 5cm poorly sorted angular to subrounded quartz pebbles supported by a matrix of sand, silt and clay. Its thickness is about 2.5 m, developing 0.4% of the total area. This facies indicates lateral accumulation of high energy shallow braided rivers.

4. Trough Cross–Bedded Sandstone Facies (St):

This facies is composed mainly of well-developed yellowish white, yellowish, to brown and grey 1- 2.5 mm medium to coarse grained sandstone with minor amounts of pebbles; formed approximately 288m in thickness and represents 84.4 % of the total area. Large scale types always found at the base and decreased upwards according to the decrease in current intensity. Generally, it has an erosional gravel strewn base with mud clasts and pebbles dispersed within the facies (see Plate 1, Photo 4).

5. Planar Cross- Bedded Sandstone Facies (Sp).

Composed mainly of yellowish to brownish, medium to coarse grained moderately sorted sandstone. Pebbles of quartz occur either dispersed within the facies or as basal lag (see Plate 1, photo. 5). Total facies thickness is equal to 4.25 meters, denotes 1.6% of the studied area and suggesting lateral accumulation of sandy braided rivers.

6. Horizontally Stratified Sandstone Facies (Sh):

The facies is distinguished by 0.5 – 1 meters whitish to yellowish, medium to coarse grained sandstone characterized by flat, parallel lamination, with parting lineation occurring on bedding planes. (see Plate 1 photo.6).

7. Ripple Cross – Laminated Sandstone Facies (Sr).

Cossets of laminated and climbing ripples of silty to fine sand from decimeters to meter in scale. The facies average thickness generally about 17cm and restricted to some location compared with other facies (see Plate 1, photo. 7).

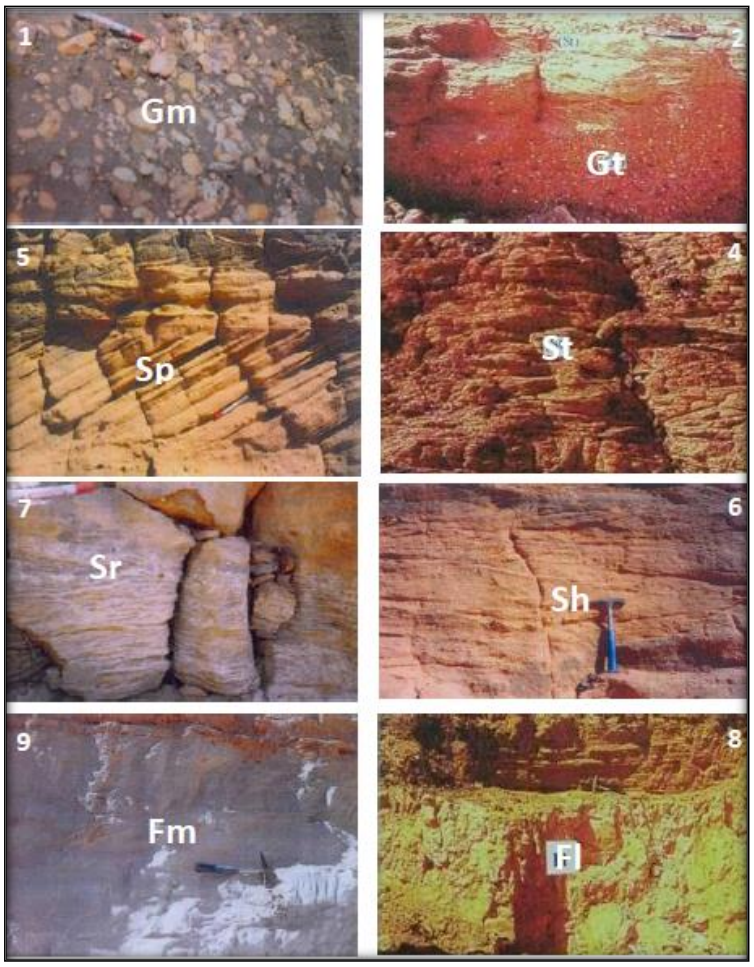
8. Fine Laminated Mudstone Facies (Fl):

This facies is composed primarily of brown, white and grey fine laminated mudstone. The facies thickness is equal to 14.55 meters, represents 5.4 % of the total studied area and suggests overbanks deposits and crevasse splay (see Plate 1, photo 8).

9. Massive Mudstone Facies (Fm):

Composed mainly of red, white and grey mudstone. Its total thickness equal to 2.9 meters formed 1.1% of the total studied area. The small thickness about a few centimeters suggest mud drape wherein the large thickness exceeding 1 meter indicates overbanks deposits (see Plate 1, photo 9).

Plate No. (1)



Lateral Profiles and Architectural Elements:

A total of 19 lateral profiles (figure 4) were mapped, photographed, and subdivided into facies based on sedimentary structures, lithology, and architecture. The identification of bounding surfaces followed Miall's (1996) methodology, revealing second-order surfaces indicating flow condition changes and third- to fifth-order surfaces marking channel bases or sequence boundaries.

According to methodology and conceptual framework of Miall (1988 b; 1985, 1995 a; 1996 and 2014) and Harishidayat D., *et.al* (2024) six architectural elements were identified within the Merkhiyat Member, Omdurman Formation, including channels, overbank deposits, crevasse splays, levees, and floodplain deposits (see Table 4). These elements reflect the depositional settings, predominantly braided and meandering river systems.

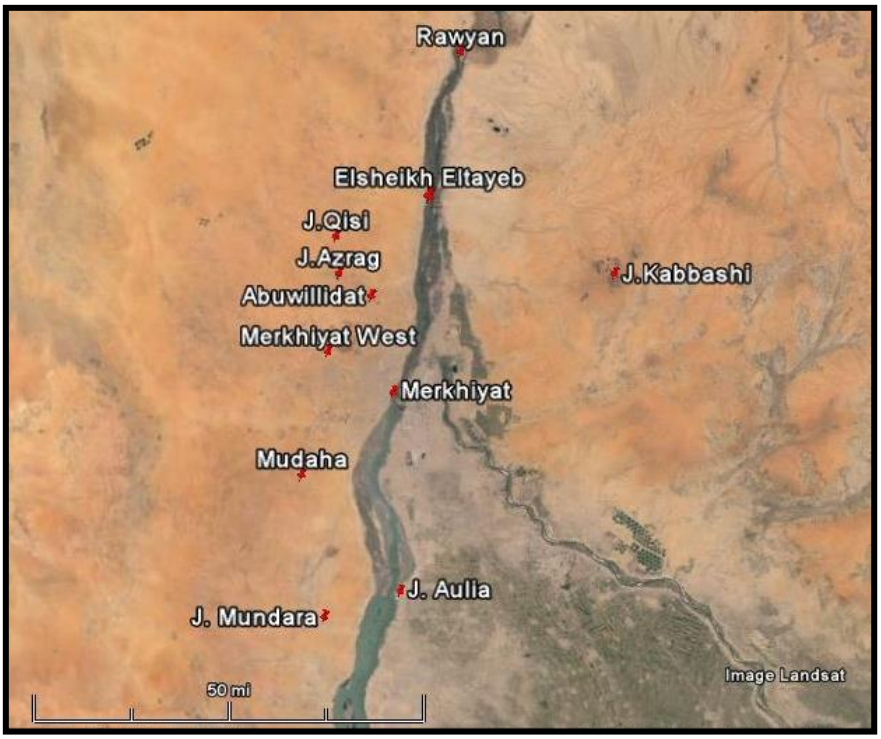
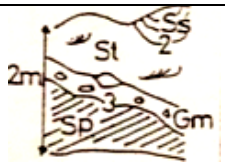
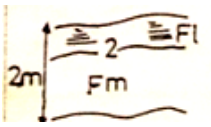
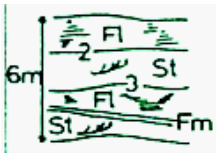
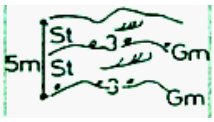


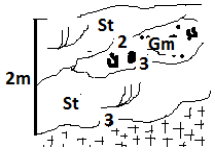
Figure 4 geographic location map of the measured stratigraphic sections

Table 3 Relative facies types abundance for lateral profiles in the study area in terms of their thickness % after Miall (1996).

Facies / Location	Merkhiyat(1)	Abu Willidat(2)	Mudaha(4)	Omdurman west(5)	0.W(6)	O.W.(7)	J.Aulia (8)	J. Aulia (10)	J.Aulia (11)	Kabbashi(13)	Elsheikh Eltayeb(14)	Rawuyan(15)	J. Azrag(17)	J. Mundara (18)	Total area facie %
Gm	0.4	8.2	6.9	0	0	0	0	0	0	11.11	2.2	43.5	3.16	27.6	6.4
Gp	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.05
Gt	0	0	0	0	0	0	0	0	0	0	0	9.9	0	0	2.2
St	88.5	86.6	65.1	0	0	0	64.5	82.1	47.6	88.8	97.6	46.6	96.8	72.4	60.5
Sp	11.1	5.2	27.9	0	0	0	0	0	0	0	0	0	0	0	1.5
Fl	0	0	0	57.3	12.5	33.3	32	44	0.1	0	0	0	0	0	19.8
Fm	0	0	0	57.3	12.5	33.3	3.2	44	0.1	0	0	0	0	0	9.7

Table 4 Architectural elements in fluvial deposits of Merkhiyat Member

Location	Element	Sketch / scale	Symbol	Principal Facies	Geometry In meters	Interpretation
Merkhiyat (1)	Major s.st sheet Sandy bedform		CHs SB	St, Sp Sm, Gm	Sheet occurs as channel fills (H 5 & W 30)	Braided shallow channel deposits
Abu Willida t (2)	Major s.st sheet Sandy bedform		CHs SB	St, Sp Gm	Sheet occurs as channel fills (H 8 & W 40)	shallow channel deposits
Mudaha (4)	Downstream accretion macro forms		DA	St, Sp, Ss	Lens resting or channel base (H 2 & W 6)	Accretionary deposits associated with channel fill and large mud clasts
Merkhiyat west (5,6&7)	Flood plain		FFP FFD	Fm, FI	Thinly bedded sheet (H 1-2 & W 1-8)	Proximal and distal flood plain deposits
J. Aulia (8)	Overbank fines Major s.st sheet		FFP CHs	Sr, FI, P St, Sh	Thinly bedded sheet sandstone sheet (H 6 & W 20)	Proximal flood plain deposits, levee deposits and drape deposit
J. Aulia (10 &11)	Major s.st sheet Overbank fines Major s.st sheet		CHs FFP SB	St FI St	Thinly bedded sheet within interbedded units of SB and CH (H 6 & W 40)	Crevasse splay deposits and abandoned channel deposits
Kabbashi	Major s.st sheet		CHs	St, Gm	Shape sheet, concave base, (H 5 & W	Braided fluvial channel

(13)					25)	
Eltayeb (14)	Major s.st sheet Sandy bedform		CHs SB	St, Gm	Concave up erosional base sheet occurs as channel fill (H 9 & W 39)	Shallow channel deposits
Rawuyan (15)	Major s.st sheet Major gravel sheet		CHs CHg	St, Gm Gm, St	Sheets occur as channel fill (H 2 & W 6)	Shallow braided channel a proximal rivers or Alluvial fan
Azrag (17)	Sandy bedform		SB	St, Gm	Sheets occur as channel fill (H 8 & W 20)	Vertically stacked sheeted channel sandstone
Mundara (19)	channel sandstone gravelly channel fill		CHs CHg	St, Gm	Concave up erosional base sheet sandstone (H 6 & W 14)	Shallow braided channel And bar deposits

Description of lateral profiles:

The location of (19) lateral profiles in the study area are chosen carefully(figure 4) , these profiles are mapped, photographed and subdivided into facies based on all facies aspect such as primary sedimentary structures, lithology, texture and composition.

Profile (1): Merkhiyat:

Consists mainly of trough cross-stratified facies formed about 88.5 % of the total area of the profile, planar cross-stratified facies, and massive sandstone facies. These facies formed the architectural elements major sandstone channel and sandy bedform and indicate shallow braided channel deposits. The architectural element (CHs) is characterized by concave up erosional base, shape sheet, 2.5m thick (see Figure 5).

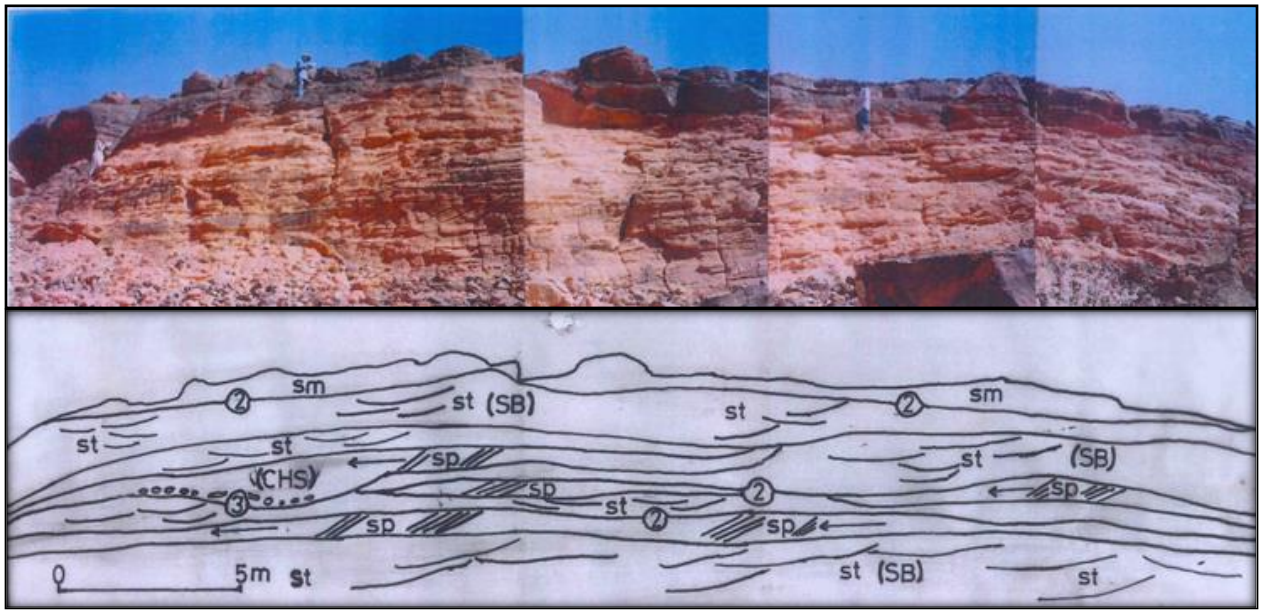


Figure 5 braided Channel Facies (Jebel Merkhiyat profile (1), Merkhiyat Member)

Profile (2): J. Abu Willidat:

This is a shallow braided channel fill deposits consist of trough and planar cross-bedded facies. The (St) facies dominate others and making about 86.6% of the profile area. The architectural elements include major sandstone channel in the lower part of the profile over lain by sandy bedform.

Profile (3): J. Mudaha:

Consists of trough and planar cross- stratified facies .The dominate facies is St building about 77.7% of the profile area. These facies formed the architectural element major sandstone channel. The element is characterized by lens to sheet shape with concave up erosional base contains large amount of mud clast (20-30cm) in diameter. This element indicates shallow braided channel fill.

Profile (4): J. Mudaha:

This profile consists of trough and planar cross-stratified facies and scour fill facies. The (St) facies dominate and forming about 65% of the profile area. These facies form the architectural element downstream accretion macroform. The element is characterized by lens resting on or channel base consist of large mud clasts. The (DA) element indicates accretionary deposits associated with channel fill and large mud clasts (see Figure 6).

Profiles: (5, 6 and 7): west Omdurman:

These profiles consist of laminated mudstone facies of proximal overbank deposits representing the architectural element (FFP) interbedded with massive mudstone facies representing distal flood plain architectural element (FFD). These elements are characterized by thinly bedded sheets and indicate proximal and distal flood plain deposits (see Figure 7).

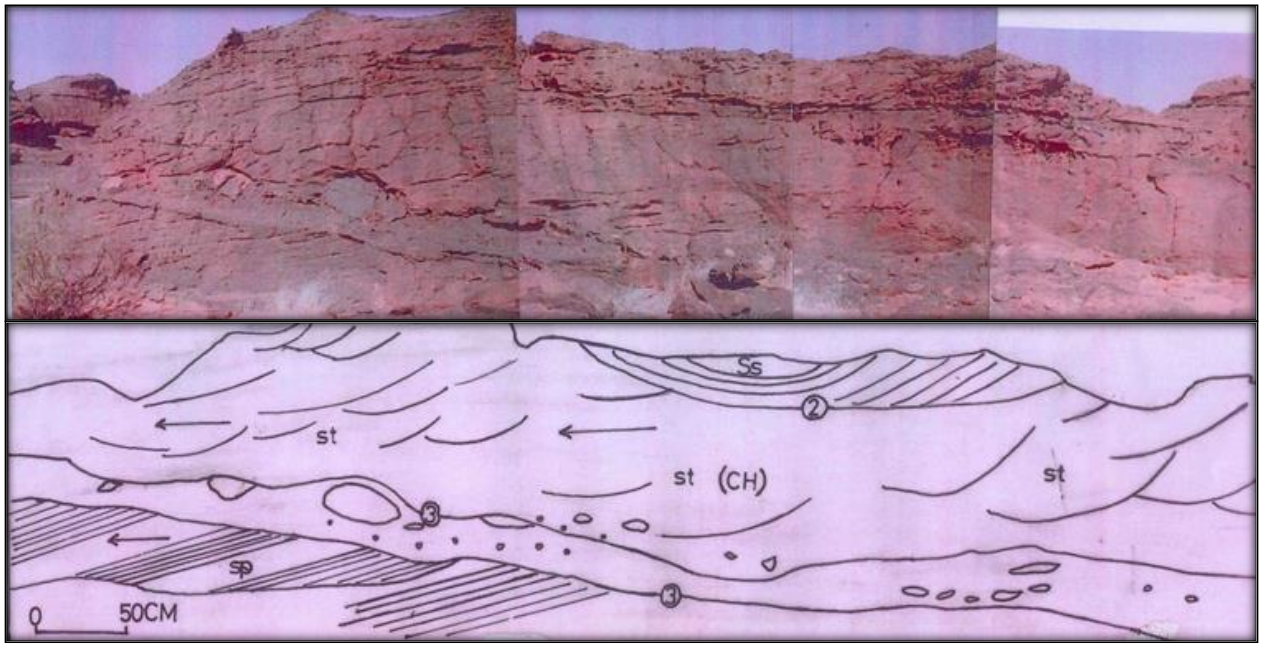


Figure 6 braided Stream Facies (Jebel Mudaha profiles (3&4), Merkhiyat Member)

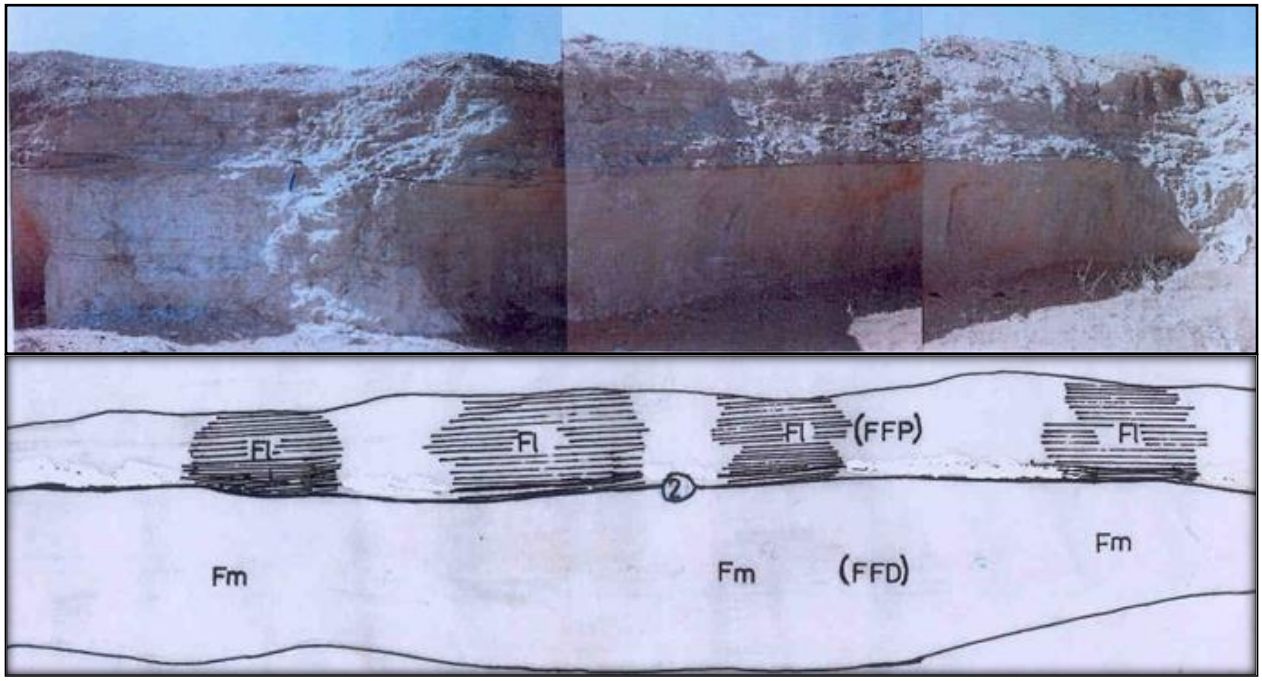


Figure 7 over bank Deposits Facies (Omdurman West profiles (5, 6, 7 & 18), Merkhiyat Member)

Profile (8): Jebel Aulia

Consists of predominantly trough cross-stratified facies, making about 64.5% of the area, and horizontally stratified facies. These facies form the architectural element major sandstone channel at the lower part of the profile. The element is characterized by thinly bedded sheet with near straight erosion base. This element indicates abandoned channel deposits. At the upper most part of the profile the rippled cross - laminated sandstone facies and laminated mudstone facies are formed thin layers represent overbank deposits element indicates proximal overbank and levee deposits (see Figure 8)

Profile (9): J. Aulia:

This profile consists of laminated mudstone facies and massive mudstone facies at the upper part of the profile. These facies represent the architectural element proximal overbank deposits. The (Fm) facies formed thin layers (5-10cm) in thickness representing mud drapes which deposit from standing pools of water during low stage channel abandonment. At the lower part of the profile, the sandy bedform element is represented by trough cross-stratified sandstone facies. This element indicates crevasse splay deposits.

Profiles (10 and 11): J. Aulia:

These profiles consist of laminated mudstone facies formed into thin tabular layers of architectural element proximal overbank deposits. This element is interbedded with unit (SB) and (CH) architectural elements which represented by trough cross-stratified sandstone facies these elements indicate shallow channel deposits interbedded with overbank deposits (see Figure 8).

Profile (12): J. Aulia:

Consists of trough cross-stratified sandstone facies at the base of the section, overlain by trough cross-stratified conglomerate facies. The two facies form the architectural element channel which is interpreted as shallow braided channel fill and mid bar deposits. The element (CH) is characterized by sheet typical thickness with nearly horizontal base.

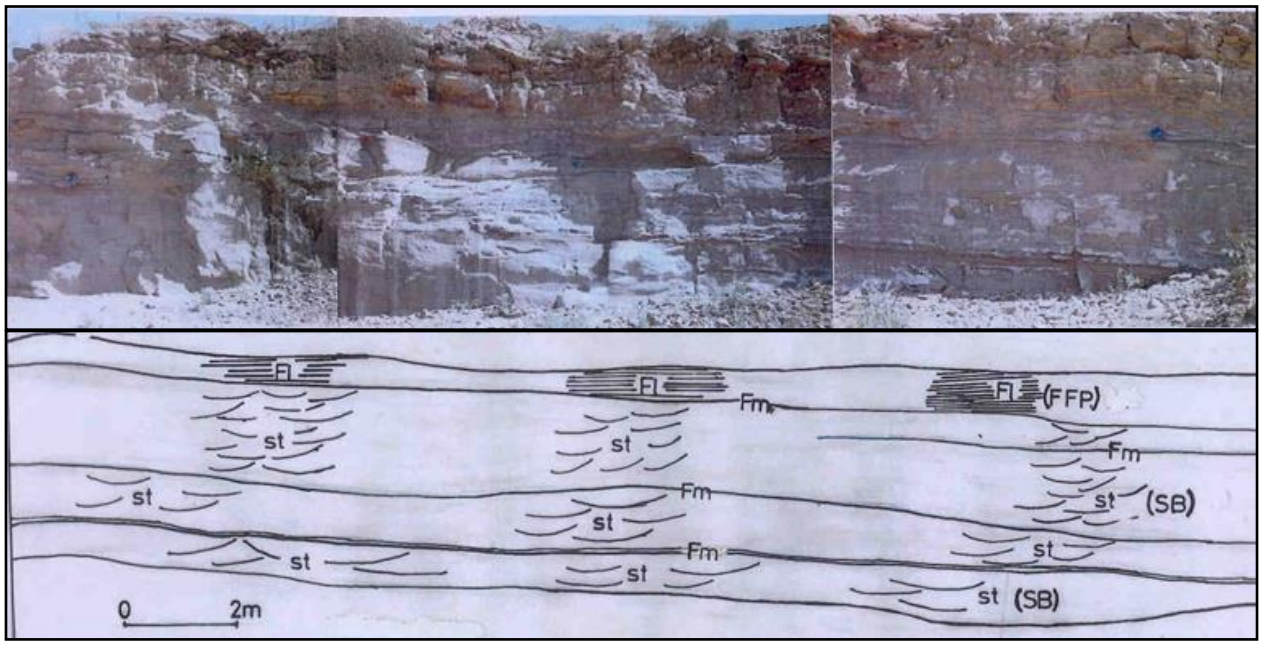


Figure 8 point Bar Facies (Jebel Aulia profile (8, 9, 10, 11&12), Merkhiyat Member)

Profile (13): J. Ibrahim Kabbashi:

Vertically stacked channel sandstone consists of trough cross-bedded sandstone facies, dominate the profile (about 88% of the area) with subordinate matrix-supported massive conglomerate facies. The architectural elements include channel which characterized by upper erosional base and sheet geometry, plus element (CH) interpreted as braided fluvial channel.

Profile (14): J. Elsheikh Eltayeb:

The profile consists of trough cross-stratified sandstone facies, which makes about 97.6% of the area of the profile, and matrix-supported massive conglomerate facies. The sandstone is locally silicified. Architectural elements include channel sandstone vertically stacked, and sandy bedform. These elements indicate shallow braided channel deposits. The element (CHs) is characterized by concave up erosional base and commonly has multi-story fills, each story bounded by an erosion surface. The element (SB) is characterized by sheet like channels, sloping at a few degrees or less.

Profile (15): J. Rawuyan:

Sandy channel fill deposits consist of trough cross-stratified sandstone facies and trough-stratified conglomerate facies. These facies form the architectural element (CHs). The gravelly channel fill deposits consist of matrix-supported massive conglomerate and form the architectural element (CHg). This element is interpreted as proximal braided rivers or alluvial fan deposits. The unconformity between the Basement and the Nubian sandstone is wide-open here.

Profile (16): J. Qisi

The profile is formed of vertically stacked shallow channel sandstone deposits consist of matrix-supported massive conglomerate and trough cross-bedded sandstone facies dominate all over the profile. These facies formed the architectural element sandy bedform which is characterized by sheet like channel fill.

Profile (17): J. Azrag:

The profile consists of trough cross-stratified sandstone facies with subordinate, matrix-supported massive conglomerate. The two facies form the architectural element sandy bedform. The element is characterized by sheet like form with a nearly horizontal erosional base. The element is interpreted as shallow braided channel deposits.

Profile (18): Merkhiyat West:

Thinly bedded facies is consisting of laminated fine grained siltstone and massive mudstone. These facies formed two architectural elements; proximal flood plain deposits, interbedded with distal overbank fine deposits. These architectural elements characterize the overbank deposits.

Profile (19): J. Mundara:

The profile consists of trough cross-stratified sandstone facies forms the architectural element sandy channel fill, and 3 meters of matrix- supported massive conglomerate forming the architectural element gravelly channel fill. These architectural elements are characterized by a concave up erosional base and indicate shallow braided channel and bar deposits.

Lithofacies Association:

Facies type abundances have been calculated for all vertical and lateral profiles (Figure 3). The facies area in square meters as a percentage of the area of each lateral profile, and also as a percentage of the total areas of all lateral profiles are calculated in (Table 3).

From vertical and laterals profiles data three types of lithofacies association are defined these are:

1. Braided Stream facies: composed mainly of whitish, yellowish to brownish, moderately sorted, medium to coarse grained. trough, planar and horizontal crossed bedded sandstone facies (St, Sp and Sh); with subordinate amounts of Gm, Gt and Gp angular to subrounded, poorly sorted and supported by poorly sorted matrix of sand, silt and mud (see Table 3 and Figure 9).

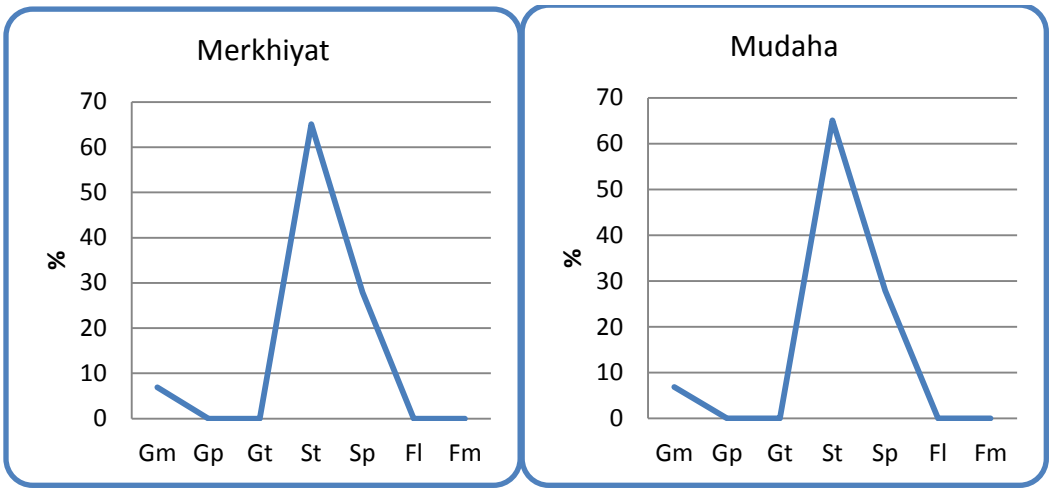


Figure 9 braided Stream facies (Merkhiyat and Abu Willidat, Merkhiyat Member)

2. Meandering Stream facies: It composed essentially of whitish, brownish, grey and yellowish, fine to medium trough, planar and horizontal crossed bedded sandstone facies (St, Sp and Sh); with amounts of brown, white and grey fine grained to silty massive and laminated mudstone (Fm and Fl) with subordinate amount of ripple mark facies (Sr) (see Table 3 and Figure 10).

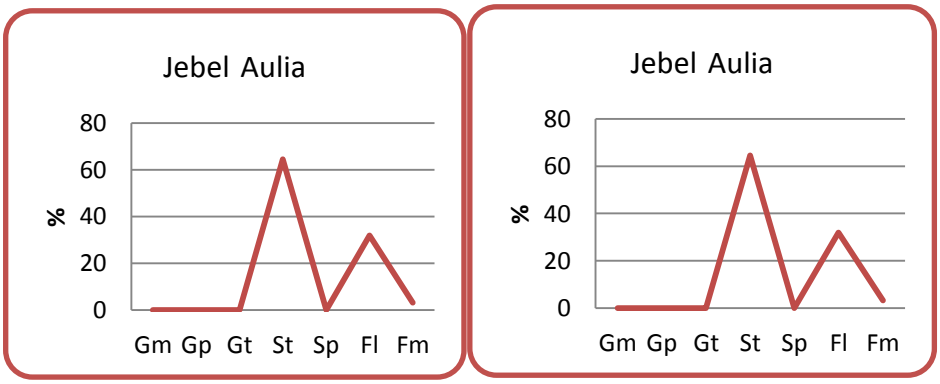


Figure 10 Meandering Stream facies (J. Aulia, Merkhiyat Member)

3. Lacustrine flood plain facies: composed mainly of brown, white and grey fine grained to silty massive and laminated mudstone (Fm and Fl) with subordinate amount of St, Sh and Sp facies (see Table 3 and Figure11).

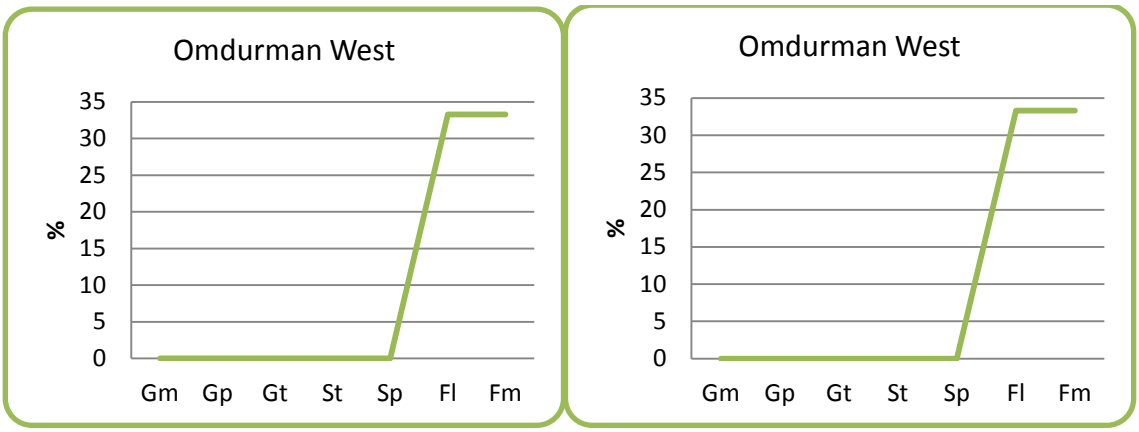


Figure 11 Flood plain facies, Merkhiyat Member)

Fossil Content and Paleoenvironmental Interpretation:

Plant fossils, mainly silicified tree trunks, were found strewn across the sandstone surfaces at multiple sites, notably Jebel Kabbashi, supporting a continental depositional environment. Fossil flora, including Cinnamomum and Cycadophyllum, suggest a late Albian to early Turonian age, consistent with microfossil data. The presence of Glossifungites burrows further supports non-marine, terrestrial or freshwater conditions.

Discussion and Depositional Environments:

Surface lithofacies analysis of lateral and vertical profiles in the study area reveal nine facies, three lithofacies association and six architectural elements; these reflect that the clastic sediments of Merkhiyat Member, Omdurman Formation might be deposited in fluvial environments. The association of (Gm, St, Sp and Sr) facies represents the sub-environments channel fill deposits and tend to dominate all over the studied area wherein (Sp) facies represents Linguoid bar deposits restricted to some location as that encountered with small thickness at J. Merkhiyat. On the other hand, the large thickness of (Gm) facies devolved at Rawuyan and Abuwillidat Jebeles is interpreted as longitudinal bars or alluvial fan deposits. The overbank facies (Fl and Fm) have been deposited from suspended load, as encountered at west Omdurman and J. Aulia, these facies represent proximal and distal flood plain and/or crevasse splay deposits.

The high percentage of sand/mud (approximately 13 to 1 table 5) reflects the dominance of sand, intensive weathering, uncohesive banks and high flow regime. The dominance of conglomerate at J. Rawuyan and J. Mundara reflects the nearby source area and supports the interpretation of alluvial fan. The absence of marine fossil and presence of silicified tree trunks besides to the common occurrence of laterite indicate a continental origin of the deposits.

Table 5 Merkhiyat Member lithofacies distribution

Facies Code	Lithofacies	Sedimentary Structure	Thickness	Flow Regime	Interpretation	Total	Sand Mud Ratio
Gm	Gravel	Massive	12.9	High	Base lag sand bars	Sand 232.25 > 90%	Approx. 13:1
St	Medium to coarse grained sand	Trough cross bedding	288	low	Dune migration		

Sp	Medium to coarse grained sand	Planar cross bedding	4.15	low	Bars deposit		
Fl	Silt + Clay	laminated	14.55	low	Flood plain	Mud 17.45 < 10%	
Fm	Clay	Massive	2.9	low	Overbank		

Depositional Model:

Integrating facies analysis, architectural elements, and fossil data indicates that the sediments of the Merkhiyat Member were deposited predominantly in braided river environments. The dominance of channel-fill facies (Gm, Gt, St, Sp) and associated overbank deposits (Fl, Fm) suggest active, high-energy fluvial systems with episodic channel switching and migration. The absence of marine fossils and the presence of terrestrial plant remains reinforce a continental setting, likely representing distal river or alluvial fan environments with occasional floodplain and crevasse splay deposits (see figure 12).

The depositional model of Merkhiyat Member can be represented by finning upward sequences reflecting allogeneic and autogenic controls on sedimentation. Base level change is controlled by gradual decrease of tectonic activity leading eventually to the dominance of an open or external drainage system during the deposition of Merkhiyat Member.

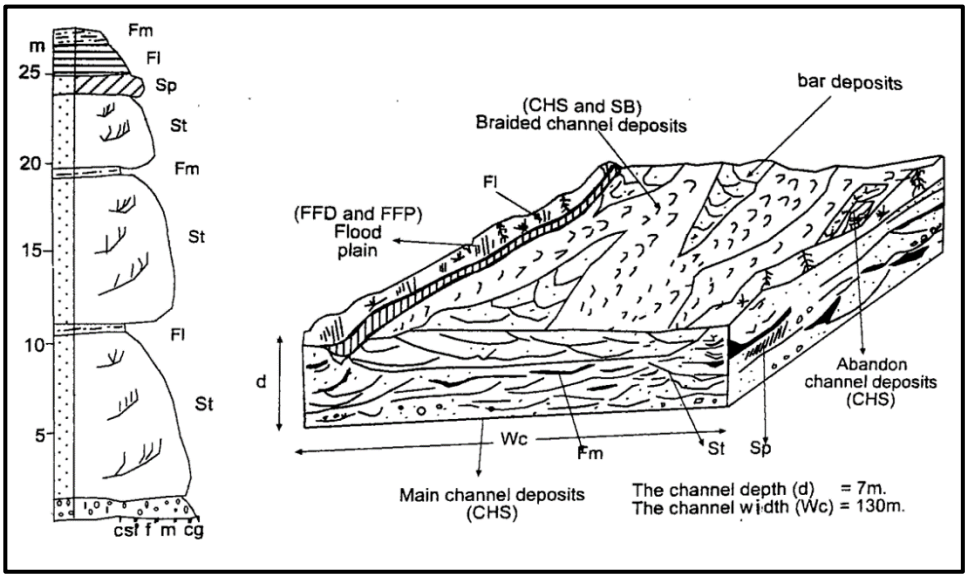


Figure 12 Conceptual Merkhiyat Member facies depositional Model (not for scale)

After (Rust, B.R., 1978b and Miall, 1987).

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Examining the Students' Attitudes towards Using Chat GPT Application in Academic Writing (During the Academic year 2025)

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Abstract:
This study aims at examining the students' Attitudes towards using Chat GPT application in enhancing academic writing among EFL university students. The researchers adopted a descriptive method that is relevant to the study. A questionnaire was used as primary tool for data collection. It was distributed to second year students of English at Faculty of Education-University of Dongola. The questionnaire sample comprises (50) students. The researchers applied a Chi-squared test to analyze and verify the hypotheses. The findings of the study revealed that: Students use Chat GPT application to improve English grammar and vocabulary. In addition, using Chat GPT application helps students organize their academic writing better and it increases students' confidence. The researchers recommended that: Teachers should teach students how to use Chat GPT application in writing lessons. Moreover, Workshops should be held to train students in using Chat GPT tools properly.

Keywords: Chat GPT, Artificial Intelligence, Academic Writing and Contexts.

مستخلص:
تهدف هذه الدراسة إلى تقصي اتجاهات الطلاب حول استخدام تطبيق جات جي بي تي (Chat GPT) في الكتابة الأكاديمية . واتبع الباحثون المنهج الوصفي الذي كان ملائما جدا للدراسة . واستخدم الاستبيان كأداة لجمع البيانات ووزع الاستبيان لطلاب السنة الثانية بكلية التربية – جامعة دنقلا. و تشمل حجم عينة الدراسة (50) طالبا و طالبة. كما طبق الباحثون اختبار مربع كاي لتحليل وتأكيد الفرضية. كشفت نتائج الدراسة أن الطلاب يستخدمون تطبيق جات جي بي تي لتحسين قواعد ومفردات اللغة الإنجليزية، وبالإضافة الي ذلك، إن استخدام تطبيق جات جي بي تي يساعد الطلاب في تنظيم كتاباتهم الأكاديمية بشكل أفضل، ويزيد من ثقتهم . ويوصي الباحثون بشدة بأن يقوم الأساتذة بتعليم الطلاب كيفية استخدام تطبيق جات جي بي تي في دروس الكتابة، وأن تُعقد ورش عمل لتدريب الطلاب على الاستخدام السليم لأدوات جات جي بي تي.

الكلمات المفتاحية:جات جي بي تي، الذكاء الاصطناعي, الكتابة الأكاديمية، سياق الكلام.

1. Introduction:

Academic writing is a critical skill for university students, especially for those studying English as a Foreign Language (EFL). It is not only a means to demonstrate understanding and knowledge but also a fundamental tool for academic success and professional communication. Despite its importance, many EFL learners struggle with the complexity of academic conventions, vocabulary, grammar, and coherent argumentation. The rapid development of Artificial Intelligence (AI), particularly large language models like Chat GPT, has introduced new possibilities for supporting writing instruction.

Chat GPT can serve as an interactive tool that assists students in idea generation, organizing thoughts, drafting, and revising texts (Brown et al., 2020). Nevertheless, questions remain about how effectively these AI tools function as both repositories of knowledge (containers) and facilitators of writing tasks, as well as concerns about overdependence and ethical implications (Santos & Pereira, 2023). This study explores these roles in the context of EFL university students to understand the benefits and challenges of integrating Chat GPT in academic writing education.

2. Statement of the Problem:

EFL university students often struggle with organizing ideas, applying academic conventions, and developing language fluency in writing. While Chat GPT is touted as an innovative AI tool, there is insufficient evidence regarding its role as a container of academic knowledge and as a facilitator of writing tasks, particularly in contexts lacking foundational writing support. This study aims to fill this gap by examining Chat GPT's impact on students' writing skills and their attitudes of its usefulness.

3. Objective of the Study:

To investigate university students' attitudes towards using Chat GPT applications in academic writing.

4. Question of the study:

What are the university students' attitudes towards using Chat GPT applications in academic writing?

5. Hypothesis of the study:

University students' have positive attitudes in using Chat GPT applications in academic writing.

6. Significance of the Study:

This study holds considerable significance as it contributes to the growing literature on AI-assisted learning by focusing specifically on Chat GPT's dual role as a knowledge container and a task assistant in academic writing. By providing empirical evidence from an EFL university context, the study offers valuable insights for educators, curriculum designers, and policymakers aiming to integrate AI tools effectively in higher education. Furthermore, understanding students' perceptions and the ethical concerns associated with Chat GPT use helps in developing guidelines that promote responsible and balanced adoption. The findings have the potential to enhance teaching strategies, improve student writing outcomes, and ensure the ethical use of emerging technologies in academic settings.

7. Methodology of the Study:

This study employed a quantitative approach to explore students' perceptions towards using ChatGPT application in academic writing. EFL University students (50) were randomly selected to represent the population of the study to gather data, a questionnaire was administered to measure EFL students' perceptions of Chat GPT benefits, ease of use, motivation, and perceived risks. Quantitative data from questionnaire were analyzed using a Chi-squared test to examine performance differences and significance. Ethical considerations, including informed consent and confidentiality, were strictly observed throughout the study.

8. Literature Review:

Definition of Academic Writing:

Academic writing is a formal style of writing used in educational and scholarly contexts, such as universities, research institutions, and academic publications. Its primary purpose is to communicate complex ideas clearly, logically, and objectively to an academic audience (Swales & Feak, 2012). Unlike casual or creative writing, academic writing demands a high level of precision, evidence-based arguments, and adherence to specific conventions.

More precisely, academic writing involves producing texts that present critical analysis, synthesis of ideas, and well-supported conclusions derived from credible sources (Hyland, 2004). It is commonly used in various genres such as research papers, essays, theses, and

literature reviews. The language in academic writing is typically formal, avoiding personal opinions, colloquialisms, and emotional expressions.

For learners of English as a Foreign Language (EFL), academic writing represents a significant challenge due to its complexity and the need to master both linguistic and rhetorical skills. It requires the ability to construct well-structured arguments, use specialized vocabulary, and properly cite sources.

Academic Writing and EFL Contexts:

Academic writing is a fundamental competency in higher education, crucial for students' academic success and future professional careers. For EFL learners, academic writing poses unique challenges due to language proficiency gaps and unfamiliarity with disciplinary conventions. According to Hyland (2003), academic writing involves mastering rhetorical structures, appropriate vocabulary, and formal tone, which require both language skills and cultural understanding. Ferris (2009) highlights common issues faced by EFL students such as limited academic vocabulary, difficulties in sentence cohesion, and structural organization. Furthermore, EFL learners often struggle to engage critically with sources and to integrate citations correctly, which are essential in maintaining academic integrity and credibility. These difficulties necessitate the development of targeted pedagogical approaches and support systems tailored to EFL students' needs.

Features of Academic Writing:

Academic writing possesses distinct characteristics that differentiate it from other forms of writing, such as creative or informal writing. Understanding these features is essential for students and researchers aiming to produce effective academic texts. The main characteristics can be categorized into formality, objectivity, clarity, precision, coherence, and evidential support.

Formality:

Academic writing is formal in tone and style. This means the language avoids casual expressions, contractions (e.g., don't, can't), slang, and colloquial phrases that are common in everyday speech or informal writing. Formality also requires the use of precise vocabulary and discipline-specific terminology where appropriate (Hyland, 2004). This formality helps establish credibility and professionalism, signaling to the reader that the writer is knowledgeable and serious about the subject matter.

Objectivity:

One of the core features of academic writing is objectivity. Writers must present information and arguments based on evidence rather than personal opinions or emotions. The use of the first person ("I think") is generally discouraged except in reflective writing or where explicitly allowed by discipline conventions (Swales & Feak, 2012). Instead, academic writing favors impersonal constructions (e.g., "It is argued that…"), passive voice when necessary, and careful wording that minimizes bias.

Clarity and Precision:

Clarity is fundamental in academic writing to ensure that readers understand the ideas without ambiguity. Writers achieve clarity by using straightforward sentence structures, defining technical terms, and avoiding unnecessary jargon unless it is essential to the discipline (Coffin et al., 2003). Precision involves choosing words that accurately convey meaning, especially when describing research findings, theories, or arguments. Ambiguous or vague language can weaken the persuasiveness of the text.

Coherence and Logical Organization:

Academic writing must be coherent, meaning that ideas flow logically from one to the next. This is achieved through the use of well-structured paragraphs, clear topic sentences, and appropriate transitional phrases (e.g., "however," "furthermore," "in contrast") that guide the reader through the argument (Leki, 1992). Coherence also requires the writer to organize

content in a systematic way, such as following the conventional essay structure of introduction, body, and conclusion, or the IMRAD format (Introduction, Methods, Results, and Discussion) in scientific writing.

Evidential Support and Citation:

Another hallmark of academic writing is the necessity to support claims with evidence from credible sources. This can include references to previous studies, data, quotations, or theoretical frameworks (Pecorari, 2013). Proper citation of sources is critical to avoid plagiarism and to demonstrate the writer's engagement with the academic community. Different disciplines use various citation styles such as APA, MLA, or Chicago, and mastering these conventions is part of academic literacy.

Critical Thinking and Argumentation:

Academic writing goes beyond mere description or summary; it requires critical analysis and evaluation of ideas. Writers must not only present facts but also interpret, compare, and synthesize information to build coherent arguments (Hyland, 2009). This involves questioning assumptions, identifying gaps in the literature, and articulating one's own position supported by evidence.

Technical Accuracy:

Grammar, punctuation, and spelling must be accurate in academic writing, as errors can distract readers and undermine the writer's authority. However, correctness alone is not sufficient; writers must also consider style and tone appropriate to their audience and purpose (Swales & Feak, 2012).

Audience Awareness:

Finally, effective academic writing demonstrates awareness of the target audience, which is typically other scholars, instructors, or students familiar with the discipline. This influences vocabulary choice, the depth of explanation, and the amount of background information provided (Connor, 1996).

These characteristics combine to make academic writing a rigorous, formal mode of communication that advances knowledge and supports scholarly dialogue. Mastering these features enables writers to present their ideas persuasively and meet the expectations of academic institutions.

Challenges in Academic Writing:

Academic writing poses several challenges for students, especially those who are non-native speakers of English. Common difficulties include grammar accuracy, limited vocabulary, lack of experience with academic genres, and poor organization. Moreover, students often struggle with critical thinking and integrating sources properly, which can lead to plagiarism. Hyland (2019) highlights that the process of mastering academic writing is gradual and demands intensive practice, feedback, and reading. In EFL contexts, additional language barriers intensify these challenges, making the teaching of academic writing essential for academic success.

Definition and Background of Chat GPT:

Chat GPT, developed by Open AI, is an advanced AI language model that uses natural language processing (NLP) to generate human-like responses. It is based on the Generative Pre-trained Transformer (GPT) architecture, specifically the GPT-4 version. As defined by Open AI (2023), Chat GPT is trained on large datasets to understand and generate language in various contexts, making it a useful tool in education, customer service, and content creation. It simulates conversation and can provide explanations, summaries, feedback, and more, making it increasingly popular in educational settings.

Chat GPT in Education:

The rapid advancement of Artificial Intelligence (AI) technologies has transformed educational practices, particularly in language learning and writing instruction. Large Language Models (LLMs) such as Chat GPT represent state-of-the-art AI applications capable of generating

coherent, context-aware text responses. Brown et al. (2020) describe Chat GPT's architecture as trained on massive datasets, enabling it to understand and produce human-like language. Holmes, Bialik, and Fadel (2022) argue that AI tools can offer personalized feedback, scaffold complex tasks, and foster learner autonomy by allowing students to interact dynamically with the system. Chat GPT, specifically, supports multiple aspects of the writing process: idea generation, drafting, revising, and vocabulary enhancement. However, the integration of AI in education raises concerns about academic honesty, potential misuse, and the risk of learners becoming overly dependent on technology (Santos & Pereira, 2023). Consequently, educators must carefully balance AI's benefits with ethical considerations.

Chat GPT and Academic Writing:

The theoretical framework of container and task assistant helps to conceptualize the multifaceted role of Chat GPT in academic writing development. As a container, Chat GPT serves as an extensive knowledge base containing linguistic data, grammar rules, academic vocabulary, and model texts that students can query to enrich their writing. This function aligns with the construct of "scaffolding," where learners access external support to bridge knowledge gaps (Kasneci *et al.,* 2023). Simultaneously, Chat GPT operates as a task assistant, facilitating the completion of discrete writing activities, such as structuring arguments, correcting syntax errors, or paraphrasing content. This task-oriented role is crucial for procedural learning, helping students apply theoretical knowledge practically and efficiently. Yuan and Zhang (2023) emphasize that this dual function encourages active learning and engagement by providing immediate, context-sensitive assistance. Yet, the challenge lies in ensuring students use ChatGPT as a cognitive tool rather than a crutch, preserving authentic skill development.

Recent studies emphasize various benefits of Chat GPT for EFL learners (Li & Chen, 2024):

1.Improved fluency and coherence: Chat GPT helps in structuring sentences and paragraphs.

2.Vocabulary enrichment: Learners get exposure to diverse lexical choices.

3.Increased motivation: Interactive Chat GPT prompts encourage engagement.

4.Immediate feedback: Allows learners to correct errors quickly.

5.Writing scaffolding: Supports different stages of the writing process.

6.These advantages can enhance writing performance and learner confidence when used responsibly.

Risks and Ethical Concerns:

Despite its advantages, Chat GPT presents several risks. One major concern is over-reliance, where students may depend on Chat GPT generated content without developing their own writing skills. There is also the issue of academic dishonesty, as students might use it to generate entire essays. Additionally, Chat GPT may occasionally produce inaccurate or biased information. According to Dwivedi *et al.* (2023), the ethical use of Chat GPT in education requires clear guidelines to ensure it serves as a support tool rather than a replacement for human learning and creativity. Institutions are encouraged to implement AI literacy as part of their academic integrity policies.

9. Previous Studies:

A growing body of research has investigated the use of Chat GPT and related AI technologies in the domain of academic writing, especially for EFL students. Below is a detailed review of significant studies relevant to this study:

The first study Ali (2022) conducted a study titled "The Use of Artificial Intelligence Tools in Sudanese University Classrooms" at the University of Khartoum with a sample of 80 undergraduate students. The instruments used were a questionnaire and interviews. The study found moderate awareness of AI tools but highlighted limited practical integration due to infrastructure and training barriers.

The second study by Ahmed (2023) conducted a semester-long experimental study with 50 Egyptian university students learning academic writing. The study assessed the impact of Chat GPT on vocabulary enhancement and essay organization. Using pre- and post-tests alongside questionnaires, Ahmed found that students who used ChatGPT scored significantly higher in lexical variety and logical flow than the control group. The study concluded that Chat GPT acts as an effective container of linguistic resources that supports academic language acquisition.

The third study by Lin and Huang (2023) carried out a qualitative case study in Taiwanese universities focusing on Chat GPT's role in supporting brainstorming and revision strategies. Through interviews and reflective journals, students reported increased confidence and motivation when engaging with Chat GPT, highlighting its usefulness in overcoming writer's block. However, they also noted the necessity for instructor guidance to avoid mechanical reliance on AI-generated suggestions.

The fourth study by Smith and Alvi (2023) surveyed 150 postgraduate students in the UK and reported that 70% found Chat GPT useful for grammar correction and idea generation. However, instructors emphasized the need for training in ethical usage.

Chen et al. (2024) analyzed AI-assisted writing in Chinese academic settings. Findings showed that students using Chat GPT scored higher in clarity and organization compared to the traditional group.

The fifth study by Musa (2024) examined Sudanese EFL students' grammatical accuracy improvements through AI-assisted writing feedback. Employing a mixed-methods approach with 40 participants, Musa administered pre/post grammar tests and conducted semi-structured interviews. Findings revealed significant reductions in common grammatical errors and increased awareness of academic conventions among students using Chat GPT, reinforcing its role as both container and task assistant.

10. Data Analysis:

Quantitative data from Questionnaire responses were subjected to descriptive statistical analysis.

Table (1) data analysis Chi-Square Value.

Statement	Chi-Square Value	p-value	Statistically Significant
I use Chat GPT to improve the grammar and vocabulary of my academic writing.	30.330	0.000	Yes
Chat GPT helps me understand academic writing conventions (e.g., introductions, thesis statements).	14.782	0.001	Yes
Chat GPT enhances my ability to write with better coherence and cohesion.	3.728	0.155	No
I learn new academic expressions by using Chat GPT.	2.058	0.357	No
Chat GPT improves my critical thinking while writing academic texts.	16.358	0.000	Yes
I feel more confident in my academic writing after using Chat GPT.	1.518	0.468	No
Chat GPT increases my motivation to complete writing assignments.	16.118	0.000	Yes
Chat GPT saves my time and effort when writing academic papers.	2.812	0.245	No
I find it difficult to trust the accuracy of Chat GPT's responses.	3.124	0.099	No

Chat GPT sometimes gives me vague or incomplete answers.	2.812	0.245	No
I feel unsure whether the content generated by Chat GPT is academically acceptable.	12.284	0.002	Yes
I struggle to verify the references or sources used by Chat GPT.	1.523	0.467	No
Chat GPT lacks subject-specific depth for my writing needs.	24.525	0.000	Yes
Chat GPT sometimes misinterprets the prompts I give.	5.732	0.057	No
I depend too much on Chat GPT	7.005	0.030	Yes
I feel it limits my own thinking.	3.540	0.003	Yes

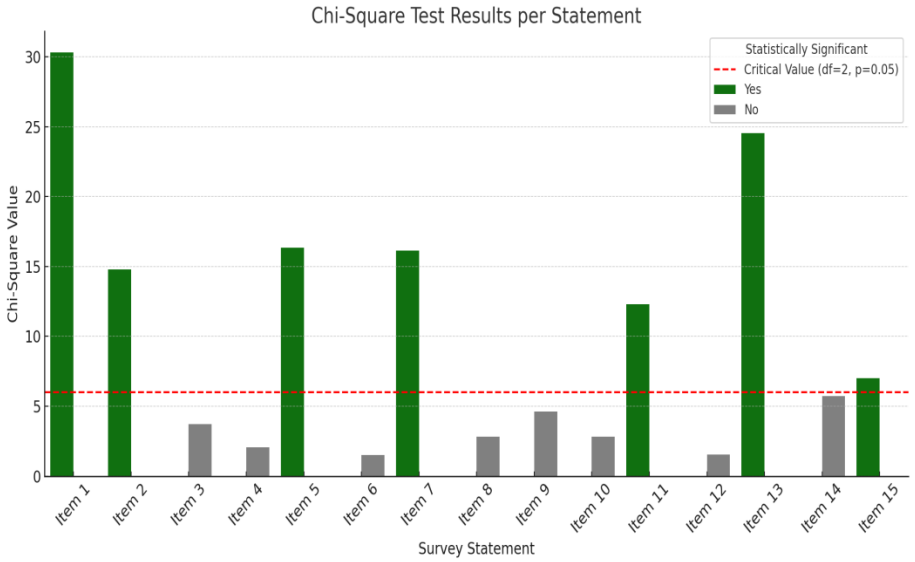

Figure (1) Data analysis Chi-Square Value.

The chi-square analysis reveals significant patterns in how students use Chat GPT for improving academic writing. Several statements yielded statistically significant results ($p < 0.05$), indicating strong agreement among students on the helpfulness of Chat GPT. For example, items with chi-square values like (30.330) ($p = 0.000$) and (24.525) ($p = 0.000$) confirm widespread acceptance of Chat GPT tools for academic language support. However, some statements had non-significant results, implying inconsistent or neutral perceptions among certain responses. This variation suggests that while a substantial number of students find Chat GPT beneficial, others may lack sufficient exposure, training, or trust in the tool. Overall, the data affirm that Chat GPT is increasingly perceived as a valuable linguistic aid but with room for more inclusive integration.

11. Discussion and the Results

The findings of the current study resonate strongly with earlier investigations into the educational use of Chat GPT, particularly in enhancing students' academic writing skills. While this study focuses on grammar and vocabulary improvements, it intersects with broader themes of AI integration in university writing support tools. In Ali (2022), the research conducted at the University of Khartoum revealed a moderate awareness of Chat GPT tools among Sudanese undergraduates. However, it identified barriers related to infrastructure and lack of faculty training. These observations provide crucial context for interpreting the mixed statistical

significance seen in the present study. While students in this study show high recognition of Chat GPT's value (as seen in chi-square values like
(30.330 and 24.525), the statistically insignificant items (p = 0.155, 0.468) may stem from similar challenges highlighted by Ali namely, limited access or lack of adequate orientation in using such tools effectively. Comparatively, Ahmed (2023) carried out a controlled experimental study with Egyptian students and reported that those who used Chat GPT exhibited higher lexical richness and better logical structuring in their essays. This aligns directly with the present findings, particularly with significant responses indicating improvements in vocabulary and grammar. Both studies converge on the idea that Chat GPT functions not only as a grammar corrector but also as a cognitive aid that facilitates better organization and flow in writing. Moreover, Lin and Huang (2023) add a valuable dimension to this discussion by focusing on Chat GPT's role in supporting brainstorming and revision. Their qualitative approach revealed an increase in students' confidence and motivation a theme that may explain the significant approval reflected in some statements in the current study. However, their caution against mechanical reliance is a reminder that while Chat GPT tools are supportive, they should not replace the critical thinking process. This echoes the current study's recommendation for guided and reflective use. In a broader context, Smith and Alvi (2023) provide survey-based data from postgraduate students in the UK, reporting that over (70%) found Chat GPT helpful in grammar correction and idea generation. Their emphasis on ethical usage parallels the current study's recommendation for teacher-led orientation and ethical instruction. It is worth noting that although geographic and academic contexts differ, both studies arrive at similar conclusions regarding the tool's usefulness and the need for regulated usage. Finally, Musa (2024), focusing again on Sudanese students, emphasized the reduction in grammatical errors and improved understanding of academic conventions through Chat GPT use. This mirrors the present findings, particularly in the high chi-square significance associated with statements about grammar and vocabulary improvement. Musa's mixed-method approach further supports the reliability of such results, reinforcing the conclusion that Chat GPT is not only perceived as effective but measurably.

So, in summary, the current study contributes to the growing body of evidence supporting Chat GPT's effectiveness in enhancing academic writing. It corroborates earlier findings regarding vocabulary development (Ahmed, 2023), revision confidence (Lin & Huang, 2023), and grammar accuracy (Musa, 2024). At the same time, it highlights the persistent infrastructural and pedagogical barriers noted in Ali (2022) and the need for ethical considerations raised by Smith and Alvi (2023). Together, these studies provide a comprehensive picture of how AI tools are reshaping academic writing landscapes across diverse educational settings.

12. Findings:

Based on the analysis of the collated data, the following findings were identified:

1.Students use Chat GPT to improve their grammar and vocabulary.

2.Using Chat GPT helps students organize their academic writing better.

3. Students are still unsure about using Chat GPT.

4.Not all students have the same access or training in using Chat GPT.

5.Students find Chat GPT useful mainly for editing and checking their writing.

6.Chat GPT increases students' confidence in academic writing.

13. Conclusion:

This study confirms that the Chat GPT application has emerged as an increasingly popular and remarkably effective tool among university students for enhancing their academic writing capabilities. The findings demonstrate a predominantly positive sentiment towards the use of this tool, substantiated by statistically significant data. This widespread acceptance and proven

efficacy suggest a potential paradigm shift in the academic landscape, where AI tools could play a pivotal role in supporting both the learning and research processes. The growing popularity of Chat GPT stems not only from its ability to rapidly generate text but also from its versatility in assisting students with idea formulation, stylistic refinement, and the correction of linguistic and grammatical errors. These features make it an invaluable companion for students striving to elevate the quality of their academic work, be it essays, research papers, or even dissertations. The study revealed that students perceive Chat GPT as a means to overcome common writing challenges, such as writer's block, difficulties in articulating complex ideas, or simply the need for a quick review of their texts. Despite this positive inclination and the data affirming the tool's effectiveness, the study also brought to light crucial areas demanding structured support. Foremost among these is the pressing need for comprehensive training for students on how to utilize Chat GPT effectively and responsibly. Such training should extend beyond mere interface instruction, encompassing a deeper understanding of the tool's capabilities and limitations, and how to integrate it into the academic writing process in a manner that fosters learning rather than hindering critical thinking. Furthermore, this training must include clear guidelines on avoiding over-reliance on the tool and maintaining academic originality. In addition to training, there is an urgent necessity to establish clear ethical guidelines governing the use of Chat GPT within the academic environment. The absence of such guidelines could lead to misuse of the tool, raising serious concerns about plagiarism, the integrity of academic work, and the development of students' fundamental skills. These guidelines should address issues such as proper attribution of information, the boundaries of assistance the tool can provide, and how to handle AI generated texts within the context of academic honesty. Developing these guidelines necessitates collaboration among educational institutions, faculty, and students to ensure a fair and transparent academic environment. Chat GPT holds immense promise for transforming the very concept of academic literacy. Rather than being merely an assistive tool, it can become a catalyst for innovation in teaching and learning methodologies. The tool has the potential to cultivate higher-order thinking skills in students by liberating them from the routine burdens of writing, thereby allowing them to concentrate more profoundly on analyzing ideas, developing arguments, and formulating complex research. However, the realization of this promise is heavily contingent upon how the tool is employed. Its use must be responsible and inclusive, ensuring that all students, irrespective of their backgrounds or abilities, can benefit from this technology in a way that enhances their learning and academic development. In conclusion, this study underscores the significant potential of Chat GPT as a tool for augmenting academic writing. Nevertheless, fully harnessing this potential requires a thoughtful approach that combines structural support through training and ethical guidelines with a commitment to responsible and inclusive usage. Consciously and wisely embracing this technology will ensure that it contributes to nurturing a generation of academics capable of critical thinking, effective writing, and positive contributions to human knowledge.

14. Recommendations:

In the light of the findings, the following recommendations are proposed:

1.Teachers should teach students how to use Chat GPT in writing lessons.

2.Workshops should be held to train students in using Chat GPT tools properly.

3.Students should be encouraged to think and write before using AI help.

4.Teachers should explain the limits of Chat GPT and when to avoid using it.

5.Instructors must guide students to use Chat GPT in the right way.

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Effect of Nitrogen Levels on Growth and Yield of Sesame (*Sesamum indicum* L.) under Irrigation Conditions

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Abstract:

Two field experiments were conducted during the summer seasons of (2021) and (2022) at the farm of the faculty of Agricultural Sciences, University of Dongola, Sudan to study the effects of N on growth and yield of sesame under irrigation conditions. A randomized complete block design with three replications was used to execute the experiment. Treatments consisted of three levels of nitrogen (0, 40 and 80 kg N/fed applied as Urea) on cultivar Promo. Data were collected on number of branches/plant, plant height (cm), date of flowering, number of capsules/plant, number of seeds/ capsule, thousand seed weight (g) and yield (kg/fed). Results revealed significant differences between nitrogen levels on number of branches per plant, plant height, flowering date and number of capsules per plant. On the other hand, there were insignificant differences between nitrogen levels on number of seeds per capsule, thousand seed weight and yield.

Keywords: Nitrogen, fertilizer, sesame and Sudan

مستخلص:

أجريت تجربة حقلية لموسمين خلال صيفي العامين (2021) و(2022) بمزرعة كلية العلوم الزراعية، جامعة دنقلا، السودان لدراسة تأثير النيتروجين على نمو وإنتاجية محصول السمسم تحت ظروف الري. استخدم للتجربة تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. شملت المعاملات ثلاثة مستويات من النيتروجين (0، 40 و80 كجم نيتروجين/ فدان (استخدم سماد اليوريا)) على صنف السمسم برومو. القراءات التي تمت دراستها شملت عدد الأفرع/النبات، ارتفاع النبات (سم)، تاريخ الإزهار، عدد الكبسولات/ النبات، عدد البذور/ الكبسولة، وزن الألف بذرة (جم) والإنتاجية (كجم/فدان). أظهرت النتائج وجود اختلافات معنوية بين مستويات النيتروجين على عدد الأفرع/النبات، ارتفاع النبات (سم)، تاريخ الإزهار و عدد الكبسولات/ النبات. من ناحية أخرى لم تكن هناك فروق معنوية بين مستويات النيتروجين علي عدد البذور/ الكبسولة، وزن الألف بذرة (جم) والإنتاجية (كجم/فدان).

Introduction:

Sudan is the third largest producer of Sesame (*Sesamum indicum* L.) in the world, after India and China. Nevertheless, it is considered the main world exporter of sesame seeds (Maryoud *et al*., 2008). Sesame is the most important oil crops grown in Sudan. The area under sesame cultivation is currently estimated at about 4,938,238 feddans. Sesame seed production in Sudan is estimated at about 450,000 MTs and is grown under rain-fed conditions by subsistence, semi commercial and commercial farmers. It contributes to Sudan's export trade and earnings. The existing wide variability in cultivated landraces and the wide spread of wild types makes Sudan an important location for sesame genetic diversity. Collection efforts between 1999 and 2008 have resulted in more than 300 accessions from areas in eastern, western and central Sudan including both cultivated and wild material with different characteristics especially seed color (Nahar, 2009). Sesame and groundnuts are the main oilseed crops grown in Sudan. Although Sudan was an important exporter of sesame, its position in world trade has declined in recent

years (Elshafie *et al*., 2007). Nitrogen is taken up by the plants from the soil in large quantity relative to other essential nutrients. It is one of the basic plant nutrients and plays role in various physiological processes of plants and acts as the constituent of compounds like amino acid, proteins, nucleic acids, enzyme, chlorophyll. thus, there is an urgent need to refine fertilizer requirement especially of N for sustained higher yield as well as superior quality product (Piyush *et al.*,2019).

Therefore, the main objective of this study was to evaluate the effects of Nitrogen on growth and yield of sesame under irrigation conditions.

Material and Methods:

The experiment of this study was conducted during the summer seasons of 2021 and 2022 at the demonstration farm of the faculty of Agricultural Sciences, University of Dongola. which is situated on the eastern bank of the River Nile (Selaim), Dongola locality, Northern State of the Sudan - located within latitude 10 and 19˚ N, and longitude 29 and 30˚ E. A randomized complete block design with three replications was used to execute the experiment. Sesame Cultivar Promo was treated three levels of nitrogen (0, 40 and 80 kg N/fed applied as Urea). Data was collected on number of branches/plant, plant height (cm) at maturity stage, date of flowering, number of capsules/plant, number of seeds/ capsule, thousand seed weight (g) and yield (kg/fed). The collected data were subjected to analysis of variance (ANOVA) appropriate for randomized complete block design (Gomez and Gomez, 1984). Duncan's Multiple Range Test (DMRT) was applied for the separation of treatment means. All statistical analyses were performed using M-STAT-C program computer package.

Results:

Number of Branches/Plant:

The statistical analysis revealed significant (P=.05) and highly significant differences (P=.01) in Number of branches/plant between the Nitrogen levels, respectively for the two seasons. In both seasons the nitrogen levels (1N and 2N) gave significantly greater Number of branches/plant over control (0N) (Table 1).

Plant Height (cm):

The results showed that Nitrogen levels differed significantly (P=.05) in the first season and highly significant (P=.01) in the second season for plant height. Application of nitrogen (1N and 2N) recorded the significantly tallest plant height over control in both seasons (Table 1).

Flowering Date:

In the first season there were insignificant differences in flowering date when nitrogen was added compared to the control. However, in the second season the addition of N (1N and 2N) led to an increase in number of days from sowing to flowering (Table 1).

Number of Capsules/ Plant:

Number of capsules per plant was significantly increased with the application of nitrogen (1N and 2N) in the first season, but there was an insignificant difference in number of capsules per plant between nitrogen levels in the second season (Table 2).

Number of Seeds/ Capsule:

Results showed that number of seeds per capsule were insignificantly affected by fertilizers levels in both seasons (Tables 2).

Thousand Seed Weight (g):

Results it indicated that the differences between N levels on thousand seed weight were insignificant in both seasons (Table 3).

Yield (kg/fed):

According to the results there were insignificant differences between nitrogen levels on seed yield (kg/ fed) in both seasons (Table 3).

Table 1: Effect of Nitrogen on Number of branches/plant, plant height and Flowering date of Sesame, seasons 2021 and 2022.

Treatment	Number of branches/plant		Plant height		Flowering date	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
0N	2.84b	1.76b	142.05b	121.71b	61.00a	62.78b
1N	4.41a	2.48a	154.57a	126.79a	63.67a	66.33a
2N	4.68a	2.74a	150.72a	132.04a	62.33a	66.67a
SE±	0.34	0.24	5.32	2.80	0.82	0.78
CV%	25.40	30.94	11.07	6.63	3.93	3.60
F values	8.65**	4.55*	7.23**	3.39*	2.67 ns	7.59**

Means within column followed by the same letter were not significantly different according to Duncan's multiple range test at 0.05 level.

*,** Significant at 0.05 and 0.01levels, respectively.

n.s Not significant at 0.05 level.

Table 2: Effect of Nitrogen on number of capsules per plant and number of seeds per capsule of Sesame, seasons 2021 and 2022.

Treatment	Number of capsules per plant		Number of seeds per capsules	
	1st season	2nd season	1st season	2nd season
0N	32.49b	10.70a	49.84a	48.66a
1N	50.40a	12.39a	42.97a	48.93a
2N	46.37a	12.50a	41.64a	45.63a
SE±	4.09	0.60	3.18	1.06
CV%	28.46	15.11	21.27	6.65
F values	5.28**	2.85 ns	1.92 ns	2.99 ns

Table 3: Effect of Nitrogen on Thousand seed yield and Yield of Sesame, seasons 2021 and 2022.

Treatment	Thousand seed weight		Yield	
	1st season	2nd season	1st season	2nd season
0N	2.88a	2.84a	688.98a	788.55a
1N	2.60a	2.89a	786.76a	786.77a
2N	2.72a	2.90a	784.21a	784.20a
SE±	0.15	0.06	53.6	87.70
CV%	16.81	6.47	30.11	33.45
F values	0.84 ns	0.30 ns	0.94 ns	0.17 ns

Discussion:

The analysis of variance showed that in both seasons the nitrogen levels (1N and 2N) gave significantly greater number of branches/plant over control. These results confirm the findings of (Piyush *et al.*, 2019 and Zenawi et al. 2020). Application of nitrogen (1N and 2N) recorded the significantly tallest plant height over control in both seasons similar results were found by (Wolfe and Kippes, 1959). The addition of N (1N and 2N) led to an increase in number of days from sowing to flowering insignificantly in the first season and significantly in the second season. Similar results were reported by (Zenawi et al. 2020). The number of capsules per plant was increased significantly and insignificantly in both seasons, respectively. These results were in agreements with the findings of (Abeje *et al.* 2016, Malik *et al.* 2003, and Olowe and Adeoniregun, 2010). On the other hand, there were insignificant differences between nitrogen doses on number of seeds per capsule, thousand seed weight and seed yield of sesame. Similar results were found by (Marcela *et al.*, 2024). But these results were in disagreement with (Mizan *et al*. 2019, Amin and Alireza, 2015, El Mahdi, 2005 and El Sherif 2016). and this may be due to the application method, hot climate and soil type.

The study concluded with the following recommendation:.

More studies with broadening scope of sesame cultivars are needed to evaluate the different N fertilization methods on sesame yield under irrigation conditions.

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Heritability and Genetic Variability on Some Wheat (*Triticum aestivum* L.) Genotypes Grown after Fall0w and Legume Crop in Northern Sudan

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Abstract:

Twelve wheat (*Triticum aestivum* L.) genotypes including four released cultivar and new promising lines were evaluated at Dongola, Sudan, over two seasons (2020, 21 – 2021, 22). Two experiments were arranged in randomized complete block design with three replications. Each experiment was grown after fallow and legume crop parallel. Estimate heritability (H^2), Genetic coefficient of variations (GCV) and genetic advance (GA) has been studied. For after fallow sowing, the highest heritability estimates in the first season was given by days to 50% heading (62.80%) and the lowest (3.99%) by number of spikelets/spike, whereas for after legume sowing the highest was given by days to maturity (93.72%) and the lowest (2.18%) by grain yield/plant for after fallow sowing.

High heritability estimates (40%) in the first season after legume and fallow sowing as shown in were given by days to 50% heading (62.80%) and days to maturity (45.67 for after legume sowing and by days to 50% heading (91.90%), days to maturity (93.72%), 1000 seed weight (48.89%) and spike length (45.81%) in fallow sowing. In the second season, high heritability estimates were given by days to 50 % heading (77.75%), days to maturity (71.64%) and 1000-seed weight for after legume sowing and by days to 50% heading (61.63%), days to maturity (51.84%), number of spikelets/spike (44.83%) and number of seed/spike (50.53%) in fallow sowing. High genetic advance in the first season was given by grain yield/plant (19.82%) for after legume sowing. while the highest GA was given by number of leaves/plant (35.18%) for fallow sowing. In the second season however, the highest estimate genetic advance was given by number of spikes/m^2 (6.69%) for after legume sowing, while for after fallow sowing the highest GA was given by stem girth (12.70%). High heritability was coupled with high genetic advance for days to 50 % heading over two seasons and in both seasons for fallow and after legume sowing and for number of spikelets/spike in the second season for fallow sowing. The genetic advance followed the same trend that of GCV but there was no definite trend between heritability and either GA or GCV. In both seasons, high heritability coupled with high genetic advance was found on days to 50% heading in fallow and after legume sowing and for number of spikelets per spike in the second season in fallow sowing. This indicates that selection of these characters will be effective.

Key words: GCV, H^2, GA, wheat.

مستخلص:

أجريت التجربة الحقلية لهذه الدراسة خلال الموسمين 2020,21/2021,22 بمزرعة البحوث الزراعية بدنقلا بتصميم القطاعات العشوائية الكاملة بثلاثة مكررات وذلك لتقييم 12 صنف من القمح (5 أصناف مجازة و 7 سلالات).اعلي درجة للتوريث سجلت في الموسم الأول لصفة عدد الأيام اللازمة لظهور السنابل بنسبة 50% (62.8%) بينما كانت الأدنى لصفة عدد السنيبلات في السنبلة (3.99%) للتجربة المنزرعة بعد المحصول البقولي بينما سجلت صفة عدد الايام اللازمة للنضج اعلي درجة للتوريث (13.72%) بينما كانت الأدنى لصفة الإنتاجية / الهكتار (2.18%) للتجربة بالأرض البور. كانت صفة الأكثر تبكيرا للأصناف Dongola pyt(69.66 و ICADRD heat Ent 10 (71.66 و pyt (69.33 و 71.66) لكلا الموسمين علي التوالي للتجربة المنزرعة بعد محصول بقولي و

(Dongla 69.66 و72) و (hala pyt 70.33 , 72.33) ICADRD heat Ent 10 (69.33 و73) للموسمين علي التوالي للتجربة المنزرعة بارض بور.

اعلي درجة توريث سجلت لصفات عدد الأيام اللازمة لظهور 50% من السنابل (62.80%) و عدد الأيام الازمة للنضج (45.67%) للتجربة المنزرعة بعد البقول للموسم الأول و الثاني علي التوالي وعدد الأيام اللازمة لظهور السنابل بنسبة 50% (91.90%) وعدد الأيام الازمة للنضج (93.72%) وطول السنبلة (45.81%) في الموسم الأول و عدد الأيام اللازمة لظهور 50% من السنابل (61.63%) وعدد الأيام اللازمة للنضج (51.84%) وعدد السنيبلات في السنبلة (44.83%) وعدد البذور في السنبلة (50.53%) في الموسم الثاني للتجربة المنزرعة بعد البور. قيمة التقدم الوراثي كانت الأعلى في صفة الإنتاجية / الهكتار (19.82%)للتجربة المنزرعة بعد البقول ولصفة عدد الاوراق في النبات (35.18%) للتجربة المنزرعة بعد البور في الموسم الأول بينما كانت لصفة عدد السنابل في المتر المربع (6.69%) للتجربة بعد البقول ولصفة سمك النبات (12.70%) للتجربة المنزرعة في الأرض البور في الموسم الثاني.

ارتبطت اعلي قيمة لدرجة التوريث مع اعلي قيمة للتقدم الوراثي لصفة عدد الايام اللازمة لظهور السنابل للموسمين ولكلا التجربتين وعدد السنيبلات في السنبلة في الموسم الثاني للتجربة المنزرعة في الأرض البور.

اتبع التقدم الوراثي GA نفس النمط لمعامل الاختلاف الوراثي GCV بينما لم يوجد نمط محدد بين درجة التوريث واي من التقدم الوراثي او معامل الاختلاف الوراثي.

Introduction:

Wheat (*Triticum aestivum* L.), belongs to the family *Poaceae (Gramineae)*. The hexaploid wheat (AABBDD) originated some 6000 – 7000 years ago by hybridization of tetraploid wheat most likely cultivated emmer (–*T. turgidum sub. Dicoccon*.), with *Aegilops tauchii subsp strangulate* (D genome) (Dvorak, 2001). The chromosomes number are 2n = 2x = 42. It's also grown on a large scale in the tropical and sub-tropical regions of the world. It ranks the first in world cereal production since it is the staple food of about one third of the world's population (Igtidar *et. al*, 2010). It is one of major staple food crops grown worldwide (Zhou *et al* 2003; Bhalla *et al*, 2006).

Wheat is the most important cereal crop in the world. It is the main grain for human consumption in the temperate regions, which are climatically very suitable for its cultivation. It is grown on a large scale in the tropical and sub-tropical regions of the world. It ranks the first in world cereal production since it is the staple food of about one third of the world's population (Igtidar *et. al*, 2010). It is one of major staple food crops grown worldwide (Zhou *etal* 2003; Bhalla *etal*, 2006).

The total world wheat area is estimated to be more than 218,000,000 hectares with average yield of 3.1 t/ha (Salah and Ismail, 2017). The straw used as an animal food. In Sudan, wheat is the second most important cereal crop after Sorghum (Ishag, 1994). It was traditionally grown since early times in the Northern state (Lat. 18-22 N). The production of wheat in Sudan was began since 2000BC. Since1946-1947, the total wheat cultivated has been increased due to improvement in productivity from 300 kg/feddan to 500 kg/feddan. The varieties grown were Gizza 155 and Maxicani.

The knowledge of genetic variability present in a given crop species for the character under improvement is of paramount importance for the success of any plant breeding program (Bisne, *et al* 2009). Heritability estimates provide information about the extent to which a particular character can be

transmitted to the successive generations. Knowledge of heritability of a trait thus guides a plant breeder to predict the behavior of succeeding generations and helps to predict the response to selection. High genetic progress coupled with high heritability estimates offer the most suitable condition for selection (Larik *et al*., 1989). Development of high-yielding varieties requires a thorough knowledge of the existing genetic variation for yield and its components. The variability is a combined estimate of genetic and environmental causes, of which only the former one is heritable. However, estimates of heritability alone do not provide an idea about the expected gain in the next generation, but have to be considered in conjunction with estimates of genetic advance, the change in mean value between generations (Mohd and Samiullah, 2006). Generally, winter wheat in Sudan is classified by short and worm (90-120 days). The main problem of wheat production in the Northern State of the Sudan, is scarcity of high yielding- early maturing varieties that suit the worm tropical climate that prevailed throughout the Sudan. Therefore, the objective of this study is to estimate genotypic coefficient of variability (GCV), heritability (H^2) and genetic advance (GA).

Materials and Methods:

The experimental work of this study was conducted during winter seasons of 2020/21 and 2021/22. It aims to evaluate the genotypic and phenotypic performance of late sown, twelve wheat (*Triticum aestivum* L.) genotypes I, sown after faba bean legume and fallow. The location of the experiments was Dongola Research Farm, located in Dongola, -Northern State of the Sudan (Latitude 19 ° - 10 ° N and Longitude 29 °- 30 ° E). Its climate is hot dry summer, low temperatures in winter, scarce rainfall, and high wind speed. The diurnal range of temperature is wide all the year round. The mean maximum and minimum temperatures are 36.4 and 18.2 °C, respectively. Temperatures as high as 49 °C are uncommon in the period extending from April to June. In winter, temperatures as low as 1.0°C have been recorded. The climate is hyper- arid with a vapour pressure of only 10.8 mb and a relative humidity of less than 20%. The mean bright sunshine duration is 10.5 hours (at 87% of possible hours). Clouds are generally rare. Solar radiation is as high as 25.88 MJM. Rainfall is scarce with a mean annual amount of 12.3mm. Wind prevails from the north southwards with mean speed of 15.7 km/hr. (Izzedin, 1996).

Materials: Twelve genotypes were used in this study

Table (1): Pedigree and genotypes names.

Genotypes source or Name	Genotypes Symbols	Pedigree
Bohuin	g_1	Released cultivar
Nebta	g_2	Released cultivar
Gummria	g_3	Released cultivar
PYT Dongla	g_4	Dongola Research genotype.
Kidir	g_5	Wad Medani Research genotype.
19PYT	g_6	Wad Medani Research genotype.
ICARDA.Elite.Ent10	g_7	NE.JMAH.14/4/BL2064//SW89.5124* 2/FASAN/3/T, LH/5/05W90045.

Imam	g_8	Released cultivar
ICARDA.Heat.Ent10	g_9	HUBARA.5/PASTOR.2/6/88ZHONG218//CTK/VEE/3/KV Z/GV//PR/4/KRAS NOVODO PADSKA YA25/5/K S82117/MLT.
ICARDA.Heat.Ent49	g_{10}	CHAM.6/PERW//MiLAN/PASTOR/3/CHAM .6/PERW/4/ATTiLA//VEE#5/DOBUCS.
ICARDA.Heat.Ent41	g_{11}	ATTiLA/HEiLo//Libya#3.
ICARDA.Heat.Ent9	g_{12}	PRL/2*PASTOR//SER1/4/MILAN/KAUZ//PR1N 1A/3/BABAX/5/HUBARA.3*2/SHUHA.4/6/KA MB2/PANDION.

Two experiments were carried out each year and over two consecutive seasons (2020/21 and 2021/22). A randomized complete block design (RCBD) with three replications was used. late in the season, sowing date was 1st February in both seasons. In both seasons sowings was done on flat by drill with seed rate of 60 kg/ha and row spacing of 20cm. Irrigation water was applied at an interval of 8and 5 days. Hand weeding was carried once three weeks after two herbicides,2,4-D and traxsos were used to control broad leaves and grasses respectively after sowing. The crop was dove at maturity.

Ten randomly selected plants were used, to record data other traits respectively in both seasons. Plant height (cm). days to 50% heading, stem girth, number of leaves, days to maturity, spike length (cm), number of spike/m, number of seed/spike, number of spike lets per spike, 1000- grain weight (g).
The collected data was subjected to the standard procedure of the analysis of variance described by Gomez and Gomez (1984) for the randomized complete block design each year separately, and then the combined analysis of variance was executed following the same procedure. Mean separation was carried by Duncan's multiple range test (DMRT) at 0.05 level of significance was performed, according to Gomez and Gomez (1984).

Genotypic ($\delta^2 g$) and phenotypic variances ($\sigma^2 ph$): were obtained from the analysis of variance Table (2) according to Comstock and Robinson (1952) as follows:

$\sigma^2 g = (MS1 - MS2) / r$

$\sigma^2 ph = \sigma^2 g + \sigma^2 e$

$\sigma^2 e = MS2.$

Where:

r: replication, MS_1: Mean square for genotype, MS_2: Mean Square for error.

Heritability in broad sense (H^2): was estimated according to Falconer (1989) as follows:

Heritability (H^2) = ($\sigma^2 g / \sigma^2 ph$) x 100

H^2: Heritability; $\delta^2 g$: genotypic variance and $\sigma^2 ph$: phenotypic variance.

Genetic coefficient of variation (GCV):

$GCV = \sqrt[2]{\sigma 2g -} / GM \times 100$ GM = grand mean

Table (2): Analysis of variance and expected mean squares for RCBD:

Source of variation	D.F	M.S	E.M.S
Replication	(r-1)	M_3	
Genotype	(v-1)	M_2	$r\sigma^2g+o^2e$
Error	(r-1)(v-1)	M_1	σ^2e
Total	(rv-1)	$(M_1+M_2+M_3)$	

Where:

r =Number of replication. v = Number of genotypes.

M_1, M_2 and M_3 =Mean squares for error, genotype and replication, respectively.

σ^2g = Genotypic variance and σ^2e = Error variance.

Table (3) Combined analysis of variance and mean squares expectations for the pooled data (combined analysis) of the two seasons.

Source of variation	D.F	M.S	E.M.S
Season	(S-1)	M_1	$\sigma^2e+vq^2r/S+vrq^2S$
Replicat x season	S(r-1)	M_2	σ^2g+vq^2r/S
Genotypes	(v-1)	M_3	$\sigma^2e+ro^2v/S+rSo^2v$
Genotypes season	(S-1)(r-1)	M_4	σ^2e+rq^2v/S
Pooled error	S(r-1)(v-1)	M_5	σ^2e
Total	S(rv-1)		

Where:

S = Number of season.

M_1, M2, M3, M4and M_5 = Mean squares for season, replication within season, genotypes, genotypes x season and pooled error, respectively.

σ^2e = pooled error variance.

σ^2r = Replicate variance.

σ^2v = genotypes variance.

σ^2r/S = variance of replicate x season interaction.

σ^2/S = variance of genotypes x season interaction.

The mean values were used for genetic analyses to determine phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), according to Singh and Chaudhury (1985) as follow:

$$\sigma^2 g = \frac{M2 - M3}{r}$$

$$\sigma^2 ph = \sigma^2 g + \sigma^2 e$$

Where:
$\sigma^2 g$ = genotypic variance.
$\sigma^2 ph$ = phenotypic variance.
= sample mean.
Genetic advance (GA) was calculated with the method suggested by Allard (1960); Singh and Chaudhury (1985) as follows:

$$GA = K.\ \sigma^2 g.\ h^2$$

Where:

GA: genetic advance, K: constant (selection differential) = 2.06 at 5% selection intensity.

GA as % of mean (GAM) = (GA / mean value) x 100

Results and Discussion:
Genetic coefficient of variation, broad sense heritability and genetic advance:

Values of genetic coefficient of variation (GCV), broad sense heritability (H^2) and genetic advance were represented in tables 4 and 5

Table (4) Estimates of the genetic coefficient of variation (G.C.V), broad sense heritability (h2) and expected genetic advance from selection (G.A) for the different characters measured for 12 genotypes at two seasons 2020/2021-2021/2022 for after legume sowing.

Characters	1st season				2nd season			
	G.C.V	h^2	G.A	GA %	G.C.V	h^2	G.A	GA%
1-Days to 50% heading	46.54	62.80	9.14	1.26	66.58	77.75	4.14	2.47
2-Days to maturity	95.48	45.67	5.88	1.39	32.53	71.64	3.59	0.67
3-plant height (cm)	19.09	24.80	5.11	0.19	10.54	38.04	3.21	0.83
4-1000 seed weight (g)	80.64	22.69	3.73	1.33	18.88	64.58	1.52	0.39
5-Number of spikes/m^2	4.37	22.39	1.91	0.29	4.20	10.93	6.69	0.42
6-Biomass (kg/ha)	-	-	-	-	-	-	-	-
7-Grain yield (kg/ha)	10.40	15.89	19.82	0.28	95.24	2.13	0.16	0.30
8-Number of leaves/plant	-	-	-	-	-	-	-	-
9-stem girth	10.000	4.11	5.32	5.32	35.48	6.66	4.82	0.37
10-Number of spikelets/	61.36	3.99	0.55	0.62	14.67	24.98	0.11	0.96

spike								
11-spike length (cm)	-	-	-	-	-	-	-	-
12-Number of seed/ spike	-	-	-	-	-	-	-	-

(-) Indicate that heritability was not estimated, because the genotypic variance was negative. The advance was calculated as a per cent of the character mean.

Table (5) Estimates of the genetic coefficient of variation (G.C.V), broadsense heritability (h2) and expected genetic advance from Selection (G.A) for the different characters measured for 12 genotypes of wheat at two-season 2020/2021-after fallow sowing.

Characters	1st season				2nd season			
	G.C.V	h^2	G.A	GA%	G.C.V	h^2	G.A	GA%
1-Days to 50%heading	260.47	91.90	8.60	2.26	70.71	61.63	3.66	1.14
2-Days to maturity	57.30	93.72	5.04	0.63	48.05	51.84	3.073	0.66
3-plant height (cm)	9.26	24.83	3.66	0.12	8.17	16.25	1.96	0.67
4-1000 seed weight (g)	50.13	48.89	2.75	0.33	23.22	30.29	2.11	0.26
5-Number of spikes/m^2	3.41	15.59	4.40	0.27	43.91	15.64	4.30	3.58
6-Biomass (kg/ha)	-	-	-	-	-	-	-	-
7-Grain yield (kg/ha)	20.57	2.18	0.033	0.15	-	-	-	-
8-Number of leaves/plant	17.20	4.27	35.18	6.51	-	-	-	-
9-stem girth	76.92	7.14	0.055	0.18	224.69	1.14	12.70	1.5
10-Number of spikelets/spike	34.21	11.83	0.27	0.14	93.02	44.83	1.11	1.29
11-spike length(cm)	195.45	45.81	0.60	0.44	-	-	-	-
12-Number of seed/ spike	7.78	18.63	2.61	0.14	3.28	50.53	6.10	0.48

(-) Indicate that heritability was not estimated, because the genotypic variance was negative.

-The genetic advance was calculated as a per cent of the character mean.

Values of the genetic coefficient of variation (GCV) were greater in the first than in the second season for days to 50% heading, days to maturity, plant height, 1000-seed weight and stem girth in fallow sowing and for days to maturity, plant height, 1000-seed weight, number of spikes/m and number of spikelets per spike for after legume sowing. On the other values of GCV were greater in the second season than first season for days to 50% heading, grain yield kg/ha and stem girth for after legume sowing and for number of spikes/m, stem girth and number of spike-lets per spike in fallow sowing. Similar results were obtained by Dargicho Dutamo, *et al* (2015), Johnson *et al.,* (1955), Hamza, (2019) and Abdaldiem (2021).

The highest GCV in the first season was given by days to maturity (95.48%) and the lowest (4.37%) by number of spikes/m, whereas, for after legume sowing, the highest was given by days to 50% heading (60.47%) and the lowest (3.41%) by number of spikes/m in fallow sowing, However, In the second season the highest GCV was given by grain yield kg/ha (95.24%) and the lowest (4.20%) by number of spikes/m for after legume sowing the highest was given by number of spike-lets per spike (93.02%) and the lowest (3.28%) by the number of seed per spike in fallow sowing. Similar results had been reported for grain yield by Abdaldiem (2021).

Regarding heritability estimate, values were greater in the second season than in the first Season for days to 50% heading, days to maturity, plant height(cm), 1000-seed and stem girth for after legume sowing, and for number of spikes/m and grain yield kg/ha was greater in fallow sowing. On the other hand, heritability values were greater in the first season than in the second season for days to 50% heading, days to maturity, plant height(cm), 1000-seed and stem girth in fallow sowing, and for number of spike-lets per spike and number of seed /spike, for after legume sowing. Similar results were obtained by Abdaldiem (2021), Hamza, (2019), Ibrahim, (1999) and khan (2003).

In fallow sowing, the highest heritability estimates in the first season was given by days to 50%heading (62.80%)and the lowest (3.99%) by number of spikelets per spike, whereas for after legume sowing the highest was given by days to maturity (93.72%) and the lowest (2.18%) by grain yield/plant for after fallow sowing. However, In the second season the highest estimates was given by days to 50% heading (77.75%)and the lowest (2.13%) by grain yield kg/ha for after legume sowing, while days to 50% heading recorded the highest (61.63%) and stem girth the lowest (1.14%) in after fallow sowing. High heritability (above 40 %) in the first season for after legume and fallow sowing were given by days to 50% heading (62.80%) and days to maturity (45.67%) for after legume sowing and by days to 50% heading (91.90%),days to maturity (93.72%), 1000- seed weight (48.89%) and spike length (45.81%) in fallow sowing. In the second season, however, high heritability estimates were given by days to 50 % heading (77.75%), days to maturity (71.64%) and 1000-seed weight for after legume sowing and by days to 50% heading (61.63%), days to maturity (51.84%), number of spikelets per spike (44.83%) and number of seed spike/spike (50.53%) in fallow sowing. Similar result was reached by Hamza, (2019) in 1000-seed weight.

It was not possible to calculate heritability for some characters because their environmental variances were greater than their corresponding phenotypic variances and hence genotypic variances for them were negative. These characters were biomass kg/ha, number of leaves/plant, spike length and number of seed spike per spike in the first season and for biomass kg/ha, number of leaves per plant, spike length and number of seeds per spike in the second season for after legume, and for biomass kg/ha in the first season and for biomass kg/ha, grain yield kg/ha, number of leaves per plant and spike length in the second season in fallow sowing. A similar difficulty in calculating heritability because of negative genotypic variances was recorded by many workers (Chekole *et al.*, 2016; ferede *etal*, 2020) and Gezahegn *et al*. 2015, in wheat, Ibrahim, 1999 in lablab bean and Ibrahim, 2009 in guar).

Estimates of genetic advance (GA) for all character followed the same trend of the heritability. Stem girth showed similar estimates over the two seasons (5.32 and 4.82) in the after legume sowing. This indicated that most of the total phenotypic variance was contributed for by genetic rather than environmental causes. In fallow sowing, characters which exhibited similar estimates of GA over the two seasons were1000- seed weight (2.75 and 2.11) and number of spikes / m. The values of genetic advance, which were expressed as per cent of the characters mean, were greater in the first than in the second season (table 4 and 5) for days to 50% heading, days to maturity, plant height(cm), 1000-seed weight, grain yield kg/ha, stem girth and number of spikelets per spike for after legume sowing and for days to 50% heading, days to maturity, plant height, 1000-seed spike and number of spikes/min fallow sowing.

Similar results were obtained by Khan ((2003), Hamza, (2019), Ferede *etal*, (2020) and Abdaldaim (2021).

The highest estimate genetic advance GA in the first season was given by grain yield kg/ha (19.82%) and the lowest by number of spike-lets per spike (0.55%) for after legume sowing. while the highest GA was given by number of leaves per plant (35.18%) and the lowest by stem girth (0.05%)for after fallow sowing. In the second season however, the highest estimate genetic advance was given by number of spikes/m(6.69%) and the lowest by number of spike-lets/, spike (0.11%) for after legume sowing, while in fallow sowing the highest GA was given by stem girth (12.70%) and the lowest by number of spikelets/spike (1.11%). Similar results were recorded by Dutamo (2015).

Estimate of GA was closely associated with magnitude of GCV, but there was on definite pattern of association observed between heritability estimate and either GCV or GA. Similar reaching was concluded by many workers in many crops (Dutamo,2015; Abdeldiem, 2021 in wheat Abdelmula, 1992 1n faba bean; Ibrahim, 1999 in lablab bean; Ibrahim, 2009 in guar).High heritability was coupled with high genetic advance for days to 50 % heading over both seasons in fallow and after legume sowing and for number of spikelets per spike in the second season in fallow sowing. This indicates that selection of these characters will be effective. Similar results were recorded by Dutamo (2015).

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Seasonal variation in occurrence of malaria at Nori Sector, Merowe Locality, Northern State, Sudan 2022.

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Abstract:
Malaria is one of the most important infectious diseases in tropical and subtropical regions, and continues to cause significant morbidity and mortality worldwide. This study was aimed to determine influences of seasonal variation on malaria prevalence in Nori sector, Merowe locality, a descriptive cross-sectional community based study was conducted with a sample size of 564 participants were selected, a simple random sample was used. The data collected by using structured questionnaire, observation and blood sample. The prevalence was found to be positive in 22 (3.9%) and 542 (96.1%) were negative. According to the seasonal variation the result showed high prevalence rate in autumn than winter. The research recommended that the health authority of the locality must concentrate on intensive control measures of mosquitoes and also to encourage the population to use mite on doors and windows.

Key Words: Season, variation, malaria parasite, Nori sector

Introduction:

Malaria is a major public health problem in Sudan. Almost, 75% of population is at risk of developing malaria. Malaria Transmission is seasonal and unstable in most parts of the country following rainfall from May to October. Possibility of epidemic increased with heavy rains, floods and in case of interruption of control activities (1). According to public health facilities, 586,827 confirmed cases were reported out of the estimated 1,400,000 cases (970,000; 1,900,000) in 2015. As well, 868 deaths were reported out of the estimated 3,500 deaths (130; 6800). The reported malaria cases represent 8.7% and 12.2% of the total outpatient attendance and of hospital admissions respectively (2). The disease proportional mortality was 4.3% in 2015 putting malaria as one of the main causes of death in Sudan (Sudan MIS 2016). According to the Sudan Malaria Indicators Survey in 2016 (Sudan MIS 2016), the overall parasite prevalence of 5.9%(3). The prevalence range is between <1 in Red Sea, Northern, River Nile and Khartoum States to >20% in Central Darfur State. In South Darfur, West Darfur, Blue Nile and South Kordofan states the prevalence approached or exceeded 10%. The prevalence correlates with age, as children are 3 times more likely to get malaria than adults. Apparently there was no difference between male and female. Similarly, internally displaced people and refugee camps reported prevalence doubled that in rural areas and 3 times higher than that in urban areas. The main species is the *P. falciparum* representing 87.6% of cases. However, the *P. vivax* unexpectedly reaches 8.1% and mixed infection (*P.falciparum* &*P.v*ivax) approached 5%. *P. vivax* alone plus mixed infection exceeded 15% in North Darfur, West Darfur, South Darfur, River Nile and Khartoum states. The main vector species is *Anopheles arabiensis* besides *An. Gambia* and *An. Funestus(4)*. Malaria Transmission is seasonal and unstable in most parts of the country following rainfall from May to October. Possibility of epidemic increased with heavy rains, floods and in case of interruption of control activities (5). On the other hand, the climate

in north Sudan two seasons, summer and winter, there is no or few rain. The study aimed to study the influences of seasonal variation on prevalence of malaria at Nori sector, Merowe locality.

Materials and Methods:

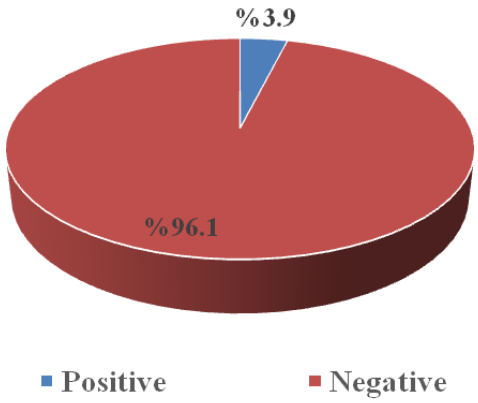
This was a cross sectional community based study conducted at Nori sector, Merowe locality in period from 2021 to 2022. Study population included people lives in Merowe locality. A sample of 564 was drawn and a simple random sample was used to select the study participants. The data was collected by structured questionnaire and blood samples. The data presented in tables and graphs, after that statistical analysis applied by 95 % confidence degree by using chi square test of significant.

Ethical permission for the study was obtained prior collection of data, after contacting and receiving approval from the appropriate authority counsel, the health director of the city involved.

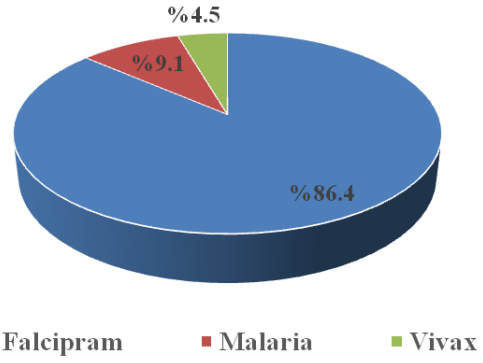
Participants consent was taken before collection of data. Also the study followed the standard guidelines, and avoidance of harm.

Results:

Graph (1) Distribution of malaria prevalence among study sample Nori sector 2022.



Graph(2) Distribution of parasite type among study sample Nori sector 2022.



Table(1)Association of season and Sample test among study sample 2022.

The season	Sample test		Total	*P value*
	Positive	Negative		
Summer	12	270	282	*0.664*
	(4.3%)	(95.7%)	(100%)	
Winter	10	272	282	
	(3.5%)	(96.5%)	(100%)	
Total	22	542	564	
	(3.9%)	(96.1%)	(100%)	

Source: Investigated by the researcher 2022.

The associations were not statically significant $p > 0.05$.

Table(2) Association between parasite type positive and season among study type 2022.

The reason	parasite type positive			Total	*P value*
	Falcipram	Malaria	Vivax		
Summer	9	2	1	12	*0.235*
	(75.0%)	(16.7%)	(8.3%)	(100%)	
Winter	10	0	0	10	
	(100%)	(0.0%)	(0.0%)	(100%)	
Total	19	2	1	22	
	(86.4%)	(9.1%)	(4.5%)	(100%)	

Source: Investigated by the researcher 2022.

The associations were not statically significant $p > 0.05$.

Table(3) Association between residence and type of parasite positive at autumn season among study sample 2022.

Residence	If positive, the parasite type			Total	*P value*
	Falcipram	Malaria	Vivax		
Eltakar	4	0	0	4	*0.455*
	(100%)	(0%)	(0%)	(100%)	
Elraian	1	1	0	2	
	(50.0%)	(50.0%)	(0%)	(100%)	
Nori Elball	1	0	0	1	
	(100%)	(0%)	(0%)	(100%)	
Elhamadab west gabli	1	1	0	2	
	(50.0%)	(50.0%)	(0%)	(100%)	
Elhamadab Bahari	2	0	1	3	
	(66.7%)	(0%)	(33.3%)	(100%)	
Total	9	2	1	12	
	(75.0%)	(16.7%)	(8.3%)	(100%)	

Source: Investigated by the researcher 2022.

The associations were not statically significant $p > 0.05$.

Discussion:

In Sudan malaria is still a major public health problem, with almost 45% of the population living in areas that suffer from stable malaria transmission and *Plasmodium falciparum* is the predominant species and was responsible for almost 97% of malaria cases in Sudan. In association the distribution according to parasite type falciparum showed the higher percentage and followed by malaria, vivax (86.4%, 9.1%, 4.5%) respectively. Over all prevalence of malaria in Nori sector was very low 22(3.9%) positive542 (96.1%) negative which this reflected the rare rain in north Sudan than the other parts of Sudan states. The association of season and sample test among study sample were not statically significant $p > 0.05$. Also the association between residence and type of parasite positive at summer season among study sample were not statically significant $p > 0.05$. This study revealed that over all prevalence of malaria in Nori sector was very low (3.9%) positive. Based on findings. The study recommended that the health authority of the locality must concentrate on intensive control measures of mosquitoes, encourage the population to use mite on doors and windows, enhances the health education programme and encourage the population to use mosquitoes net.

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The Impact of Computer-Assisted Language Learning (CALL) on Enhancing EFL Students' Speaking Skill

(A Case Study of EFL Students at English Language Department – Faculty of Education –University of Dongola, Semester seven 2024)

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Abstract:

The study highlights the significance of Computer-Assisted Language Learning (CALL) in developing speaking skills among English as a Foreign Language(EFL) students. It aimed to assess the effectiveness of CALL in improving EFL students' speaking proficiency and to explore how CALL supports diverse learning styles among both EFL teachers and students at the University of Dongola. The study adopted the quantitative analytical method. Two tools of data collection were used; a questionnaire and pre-test and posttest. The sample was selected randomly. It consisted of 30 EFL teachers and 100 students at English Department in Faculty of Education- University of Dongola. The study found out that integrating Computer-Assisted Language Learning (CALL) in EFL classrooms significantly enhances students' speaking skills. Both teachers and students acknowledged that CALL creates a multisensory environment that supports varied learning styles. To maximize its benefits, the study recommends comprehensive computer literacy training for educators and learners. Active use of CALL technologies is encouraged to boost overall EFL speaking performance.

Key terms: Technology in Education, Computer-Assisted Language Learning (CALL), Speaking Skill, Motivation

Definitions of Key Terms:

Technology in Education: This broadly encompasses the use of various technological tools and resources within the educational context (Kumar, 2020:21).

Computer-Assisted Language Learning (CALL): Beatty (2003:11) *"defines Computer-Assisted Language Learning (CALL) as the use of computers in the learning process that leads to improvements in learners' language skill".*

Speaking Skill: Brown, (2007:13) defined speaking skill in the context of language learning and communication, as the productive oral skill that involves producing systematic verbal utterances to convey meaning, express ideas, and interact with others.
Motivation: Motivation can be defined as the process that initiates, guides, and maintains goal-oriented behaviors (Brown, 2000:54). This is identified as a factor that CALL might influence in EFL students learning.

أثر التعلم اللغوي بمساعدة الحاسوب (CALL) في تطوير مهارة المحادثة لدى طلاب اللغة الإنجليزية (دراسة حالة لطلاب قسم اللغة الإنجليزية – كلية التربية – جامعة دنقلا – الفصل الدراسي السابع (2024))

مستخلص:

تُبرز الدراسة أهمية التعلم اللغوي بمساعدة الحاسوب (CALL) في تطوير مهارات التحدث لدى طلاب اللغة الإنجليزية كلغة أجنبية. وتهدف إلى تقييم فعالية استخدام التعلم اللغوي بمساعدة الحاسوب (CALL) في تحسين كفاءة الطلاب في التحدث، واستكشاف كيف يدعم التعلم اللغوي بمساعدة الحاسوب أنماط التعلم المتنوعة لدى المعلمين والطلاب في جامعة دنقلا. اعتمدت الدراسة المنهج الكمي التحليلي، واستخدمت أداتين لجمع البيانات: الاستبيان، والاختبار القبلي والبعدي. تم اختيار العينة بشكل عشوائي، وتكونت من 30 معلمًا و100 طالب من قسم اللغة الإنجليزية بكلية التربية – جامعة دنقلا. وتوصلت الدراسة إلى نتائج اهمها أن دمج التعلم اللغوي بمساعدة الحاسوب في الفصول الدراسية يُحسن بشكل كبير من مهارات التحدث لدى الطلاب. كما أقر المعلمون والطلاب بأن التعلم اللغوي بمساعدة الحاسوب يوفر بيئة تعليمية متعددة الحواس تدعم أنماط التعلم المختلفة. ولتحقيق أقصى استفادة، توصي الدراسة بتوفير تدريب شامل في مهارات الحاسوب للمعلمين والطلاب، وتشجيع الاستخدام النشط لتقنيات التعلم اللغوي بمساعدة الحاسوب لتعزيز الأداء العام في مهارة التحدث.

المصطلحات الأساسية: التكنولوجيا في التعليم– تعلم اللغة بمساعدة الحاسوب– مهارة التحدث– الدافعية.

Introduction:

Technology has become deeply embedded in daily life and global communication, fostering increased language contact across cultures. Among various tools for language learning, Computer-Assisted Language Learning (CALL) stands out as a key method for promoting student growth. CALL integrates technological resources with pedagogical strategies, supporting learning both inside and outside the classroom. Speaking, a complex skill for EFL learners, can be significantly improved through CALL, which helps address fluency, pronunciation, and confidence challenges.

Statement of the Problem:

Computer-Assisted Language Learning (CALL), has grown into an effective method for improving EFL students' skill in speaking. There has been little research on its application and efficacy in Sudanese universities, particularly University of Dongola. EFL students have poor speaking abilities, low self-esteem, fear of public speaking, and trouble pronouncing words correctly and fluently. Therefore, the current study investigates the impact of computer assisted language learning (CALL) in enhancing EFL students' speaking skill.

Objectives of the Study:

1. To investigate the effectiveness of CALL in enhancing speaking skill among EFL students at University of Dongola.
2. To examine the impact of CALL on increasing motivation of EFL students at University of Dongola.
3. To investigate how CALL cater for different learning styles among EFL students at University of Dongola.

Questions of the Study:

1. What is the effectiveness of CALL in enhancing speaking skill among EFL students at University of Dongola?
2. To what extent can CALL help in increasing motivation of EFL students at University of Dongola?
3. To what degree can CALL cater for different learning styles among EFL students at University of Dongola?

Hypotheses of the Study:

1. Using CALL in language learning has positive effect in improving students' speaking skill at University of Dongola.
2. Adopting of CALL inside classroom increases motivation of EFL students at University of Dongola.
3. CALL can effectively cater to different learning styles among EFL students at the University of Dongola

Significance of the Study:

The findings from this study extend beyond the University of Dongola, offering valuable implications for enhancing English language instruction across Sudanese universities. CALL tools have been shown to boost speaking practice, improve pronunciation, and support greater fluency and accuracy among EFL learners. Additionally, CALL fosters motivation, enjoyment, and personalized learning by targeting individual areas for improvement.

Methodology of The Study:

The study employed quantitative and analytical methods. It targets two groups: (30) EFL university teachers and (100) EFL students from the Faculty of Education, University of Dongola. The sample was randomly selected during the 2024–2025 academic year. Data collection tools included teacher questionnaire, alongside an experimental test administered to the participant students. All collected data were analyzed using the Statistical Package for Social Sciences (SPSS) to ensure accuracy and validity.

Delimitation of the Study:

The study was limited to investigate the impact of computer-assisted language learning (CALL)in enhancing EFL students' speaking skill at English Language department - Faculty of Education-University of Dongola during the academic year (2024-2025).

Literature Review:

The use of computer technology in learning English-speaking skills has expanded rapidly, especially through Computer-Assisted Language Learning (CALL). CALL allows learners to study independently without constant teacher guidance, offering features like automatic pronunciation assessment and simulated conversational lessons. It also supports broader language acquisition through interactive tools. In Sudanese universities and institutions, however, English is taught as a foreign language using traditional textbooks and rigid classroom methods. This repetitive approach often leads to student boredom and low motivation, which in turn negatively affects their academic engagement and overall learning outcomes.

Concept of CALL:

CALL is an acronym in English which stand for "Computer Assisted Language Learning". This technique has been supported and used by uncountable learners of languages through last years and it is based on the increasing use of internet, multimedia and new technologies, as a part of a didactic resource inside the classroom. CALL takes its part in the Language teaching traditional pedagogy, presenting all kinds of virtual tools for teachers and students of a foreign language; helping the process of formation for being much more personalized, interesting and attractive (Beatty, 2003:6).

CALL is defined as the process of using computers in learning which result in learners' language improvements. By using this terminology, appropriate materials and methodologies are easily recognized by learners, teachers and researchers.

CALL environments can be a classroom, a computer lab with the teacher present, a computer lab with students working independently, or students working at a public computer, at home, or elsewhere. The microcomputer has been a central element of this for the past few decades, although notebook computers and even cell phones are beginning to be utilized.

History of CALL:

According to Chapelle (1997:53) Computer-Assisted Language Learning (CALL) has been in use since the 1960s and 70s, making it a longstanding approach in language education. Despite its early adoption, CALL continues to face challenges due to the absence of robust research methodologies and a well-defined theoretical framework.

CALL in the 1950s and 1960s:

In 1959, the PLATO system pioneered computer-based language learning, offering feedback, rewards, and structured exercises modeled on textbooks. However, it underutilized the computer's interactive potential. Later, simulation-based learning introduced branching choices and error-friendly environments, reducing stress and enhancing independent, constructivist learning, (Beatty: 2003:14).

CALL in the 1970s and 1980s:

In this period, the classification of computers was divided into three categories: mainframe computers, mini-computers and microcomputers. The former category was room-sized machines. The second one was similar to what it is recently called as a server. The latter category is what we call desktop computers or personal computers such as portables and laptops, (Bush and Crotty,1991:65).

CALL in the 1990s :

Multimedia CALL environments offer a wide range of features, as highlighted in numerous recent developments. According to Bush and Crotty (1991), evaluating narrative-driven multimedia learning involves criteria like multiple protagonists, varied plot events, learner-based choice points, and intrinsic rewards. These elements help distinguish engaging multimedia contexts from non-narrative materials that lack such depth and adaptability (Bush and Crotty, 1991:72).

Development of CALL:

Computers have supported language teaching since the 1960s, evolving alongside technological advances. CALL development spans three phases: behaviorist, communicative, and integrative (Warschauer, 1996:25).

Behaviorist CALL:

Behaviorist CALL was implemented in the 1960's and 70's, when the Audio-lingual method was mostly used, and provided students with drills and practice. This model used the computer as a tutor, presenting drills and non-judgmental feedback.

Al-Kahtani (2001) explains that Behaviorist or Structural CALL emerged in the 1960s and 1970s, focusing on repetition-based exercises to reinforce grammar and vocabulary. These programs provided feedback by checking learners' responses, aligning with structuralist views that drilling was essential for learning. However, some were criticized for lacking authentic communication, leading to their rejection despite their pedagogical consistency.

Communicative CALL:

Communicative CALL emerged between the late 1970s and early 1980s, shifting focus from form-based drills to meaningful language use (Warschauer, 1998). With the rise of personal computers, it introduced interactive programs that emphasized learner autonomy, though some were criticized for being unreliable (Al-Kahtani, 2001). This approach promoted skill practice through games, reading, and text reconstruction, using the computer as a tutor, stimulus, or tool. It encouraged student choice and interaction, even in programs not specifically designed for language learning. Additionally, tools like word processors and grammar checkers supported language use in real-world contexts, such as process writing.

Integrative CALL:

Integrative CALL, which began in the 1990s, shifts language teaching toward authentic, content-based tasks and collaborative projects. It moves beyond drills to promote lifelong, borderless learning through meaningful interaction (Malley & Chamot, 1990). This phase uses multimedia tools—like CD-ROMs combining text, sound, graphics, and video—to support simultaneous skill development in realistic contexts (Al-Kahtani, 2001). With the rise of hypermedia and internet access, learners can now explore language resources independently, navigating diverse media at their own pace.

Teaching Speaking by Using CALL:

Speaking is understood as an interactive process involving message reception, negotiation of meaning, and clear output (Butler-Pascoe & Wiburg, 2003). CALL supports this through tools like video-based simulations, dialog websites, and multimedia programs that mirror real-life interactions. Platforms such as Focus English and the Virtual Language Center offer rich resources for practicing everyday conversations. CALL enhances communicative competence via tutorial CALL for structural reinforcement and CMC for interactive, self-directed speaking practice. Oral activities like role-plays and discussions benefit from computer simulations that provide dynamic scenarios and immediate feedback. These technologies foster fluency, accuracy, and motivation by immersing learners in realistic, culturally rich communication environments.

Use of CALL in Classroom Learning:

As the price of computers continues to fall, the majority of educational institutions are now in a financial position to purchase computer systems. Because of the increased awareness among the students, teachers, and management, a computer lab is now considered an essential requirement in any educational institution. This is true regardless of the subject matter being taught. Some of the benefits are;

a) Teachers used the CALL application in their classroom for the initial introduction to language concepts and giving electronic homework. CALL can solve basic problems for teachers like student attention, maintaining their interest, and holding focus. It provides a variety of interacting activities, songs, and games that makes language learning simpler (Ellis, 2004:18).

b) CALL can be used to reinforce the teacher's classroom sessions and activities. When learners want concepts to come alive instead of using a board they use multimedia lessons that are available in CALL (Hammond, 1994:10).

c) CALL can be used to check student command of language. It can determine whether a student has become fluent in the language. Also, it determines if a student has mastered grammar and vocabulary (Kharade, *etal.* 2008:19).

Previous Studies:

In Sudan, Yasser Bella (2015) conducted a study entitled: "The Effect of Using Computer Technology on the Teaching Performance of Sudanese English Language Teachers" - University of Alzaim Alaazhari. His study revealed that while English teachers generally support using computer technology in EFL classrooms, they face challenges due to limited training and lack of resources. Building on this, the current study at the University of Dongola investigates how CALL tools—such as software, online platforms, and multimedia—enhance speaking proficiency among EFL learners. It also examines teachers and students' perceptions toward CALL's effectiveness, accessibility, and usability. By focusing on both pedagogical impact and user perception, the study highlights CALL's potential and practical challenges in Sudanese higher education.

The second study was conducted by Amir Mohammed (2017), focused on exploring "The Applicability of CALL in Teaching EFL Based on Sudanese EFL Teachers' Attitudes". University of Kassala, Sudan. Using both questionnaires (administered to 50 university and college teachers) and experimental pre/post-tests (with 30 second-year English students), the study applied quantitative and experimental methods. Students were taught reading comprehension via computer-based lessons, and data were analyzed using SPSS to evaluate hypotheses and teacher perceptions. Results showed a positive impact of CALL on student performance and highlighted its effectiveness in enhancing engagement and improving speaking skills. The study underscores CALL's value in enriching the overall learning experience.

The third study by Amani El-tayeb (2020), conducted at Omdurman Islamic University, entitled: "Investigation of the role of Information and Communication Technology (ICT) in teaching English at Gezira and Butana Universities". Using a descriptive-analytical method supported by questionnaires and expert interviews, the study highlights ICT's importance in modern EFL instruction. However, it reveals that many Sudanese university-level English teachers struggle with ICT integration due to lack of specialization. The study recommends incorporating ICT into curricula and training teachers to use it effectively. While this research focuses on ICT broadly, the current study emphasizes CALL's role in enhancing speaking skills and explores related challenges in Sudanese university classrooms.

Naiyer Azam Hashmi (2016) conducted a study at Najran University in Saudi Arabia, explored the impact of Computer-Assisted Language Learning (CALL) on Arab EFL students in higher education. Using a descriptive approach and SPSS-analyzed questionnaires, the research revealed strong student attraction to CALL tools in classroom settings. As a result, Saudi institutions increasingly integrated computer technologies to enhance language instruction and address educational challenges. The study concluded that CALL has become central to effective teaching and learning in Saudi EFL classrooms. The study emphasized that CALL not only enhances language acquisition but also transforms classroom dynamics and learner engagement. Hashmi concluded that integrating technology into EFL instruction fosters autonomy, motivation, and more authentic language exposure for EFL by Arab learners.

Methodology of the Study:

This study used both quantitative and analytical methods to assess CALL's impact on EFL speaking skills. It targeted students at the Faculty of Education – University of Dongola to measure CALL's effectiveness in improving their speaking skills. In this section, the researcher outlines the study's population, sample, and data collection tools.

Population of the Study:

The population of the study consisted of two groups. The first group included EFL teachers from different Sudanese universities. The second group comprised EFL students at Faculty of Education- University of Dongola.

Sample of the Study:

The sample of this study was chosen randomly comprising 30 teachers and hundred students. The study was carried out at Faculty of Education- University of Dongola in the Northern State of Sudan during the academic year 2024-2025.

Tools of Data Collection:

Two tools of data collection were adopted to support the study: a teachers' questionnaire, and students' pre-test and post-test. They were used to find out the students' improvement in performance when learning speaking skills using CALL.

The Questionnaire:

The researcher designed a questionnaire of (10) ten statements and one open question to explore EFL teachers' perceptions about CALL. The questionnaire was distributed to the group of the selected sample of EFL teachers. The respondents were asked to give their responses using, strongly disagree, disagree, neutral, agree, and strongly agree.

Validity of The Instruments:

In order to ensure the validity for the pre/post tests and the questionnaire's statements according to the formulation and explanation, the instruments were shown to English language professors. The final forms of the tests and the questionnaire were drawn out after taking their comments, opinions, and advice into consideration.

Reliability of the Questionnaire:

Reliability coefficient was calculated by using Pearson formula; it was (0.94). This was considered to be high reliability and sufficient for the purpose of the study. It was as follows:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum \text{Var(item)}}{\text{Var(total)}}\right)$$

Where:

- N = number of items.
- Var(item) = variance of each question.

- Var(total) = variance of the total score across participants.

The Cronbach's Alpha for this questionnaire is: $\alpha = 0.946$. It means that the questionnaire statements are very consistent with each other and the questionnaire is highly reliable.

Procedures of Data Collection:

To investigate the impact of Computer-Assisted Language Learning (CALL) on enhancing speaking skills, an experiment was conducted involving (100) Sudanese EFL students at the Faculty of Education, University of Dongola.

A pre-test was designed to assess student's speaking abilities before instructional intervention, focusing on four key components: pronunciation, fluency, oral presentation, vocabulary and grammar. In Part (1) (Pronunciation), students were evaluated on their clarity and accuracy in producing English sounds emphasizing correct articulation. Part (2) (Fluency) measured their ability to respond smoothly in short conversations. Part (3) (Oral Presentations) tested their skills in organizing and delivering short talks. Part (4) (Vocabulary and Grammar) assessed their use of appropriate vocabulary and grammar.

After this baseline assessment, the students received targeted instruction using Computer-Assisted Language Learning (CALL) tools all through the 8 weeks of instruction which were instructed by the researcher. These tools helped students improve topic selection, presentation delivery, and idea development. Then the students were given the post-test which was matching the pre-test in both the number and quality of questions, to evaluate any improvements in speaking skill. By comparing pre- and post-test results, the researcher aimed to determine the effectiveness of CALL-based instruction in enhancing EFL students' speaking proficiency.

The second instrument i.e. the questionnaire was distributed and analysed as shown in the following sections.

Data analysis and Discussion:

Analysis of the Teachers' Questionnaire:

This section explores university teachers' perceptions toward CALL in enhancing EFL students' speaking skills through a questionnaire which was distributed to (30) EFL teachers at the Faculty of Education, the data were analyzed using SPSS and presented in tables. The results were discussed in relation to the study's hypotheses, integrating insights from both questionnaire and test findings.

Table (1) EFL teachers find difficulties in applying CALL inside classroom

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	8	26.67	26.67
Agree	14	46.67	46.67
Neutral	5	16.67	16.67
Disagree	1	3.33	3.33
Strongly disagree	2	6.67	6.67
Total	30	100.00	100

Table (1) reveals that (73.04%) of EFL teachers face challenges in implementing CALL in Sudanese classrooms. Key obstacles include limited access to computers and internet, lack of technical support, and insufficient ICT training. Traditional teaching methods remain dominant, with some educators resisting technology due to discomfort or unfamiliarity. This resistance, combined with infrastructural and professional gaps, significantly impedes CALL integration.

Table (2) Exploiting CALL in classroom is beneficial for improving EFL students' speaking skill.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	9	30.00	30.00
Agree	16	53.33	53.33
Neutral	2	6.67	6.67
Disagree	2	6.67	6.67
Strongly disagree	1	3.33	3.33
Total	30	100.00	100

Table (2) reveals a strong consensus among participants regarding the importance of Computer-Assisted Language Learning (CALL) in enhancing EFL students' speaking skills. A significant majority (83.33%) emphasized its importance, with (53.33%) specifically noting its role in improving the production and comprehension of spoken utterances. Furthermore, (30.00%) of respondents strongly agree that CALL programs should be integrated into EFL classrooms due to their effectiveness in fostering speaking proficiency and providing meaningful educational activities.

Table (3) Teachers spend more time in preparing lessons using CALL.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	2	6.67	6.67
Agree	2	6.67	6.67
Neutral	5	16.67	16.67
Disagree	10	33.33	33.33
Strongly disagree	11	36.67	36.67
Total	30	100.00	100

Table (3) shows the impact of CALL in helping EFL teachers in preparing their lessons. CALL has a great importance in lesson planning and preparation in higher education which can improve both teachers and student's academic outcomes. The results regarding this statement reveal that (36.67%) of the respondents strongly disagree to the above statement. In the same line (33.33%) of the participants disagree. The results reflect that (70.00%) of the teachers do not spend more time in preparing their lessons. On the other side, computer assisted programs can offer EFL teachers' instant feedback when preparing new lesson.

Table (4) The use of CALL increases students' participation in various classroom activities.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	13	43.33	43.33
Agree	15	50.00	50.00
Neutral	1	3.33	3.33
Disagree	1	3.33	3.33
Strongly disagree	0	0.00	0.00
Total	30	100.00	100

The above table shows (50.0%) of the respondents agree with the statement, and (43.33%) strongly agree. The majority of the participants (93.33%) emphasized that technology and computers help and encourage EFL students to interact together. Moreover, they help them involve different ways of learning styles and practicing speaking skill. Furthermore, Technology gives learners a chance to engage independently, provide opportunities for self-paced

interactions, privacy, and safe environment where mistakes are corrected and exact feedback is given.

Table (5) Using CALL in teaching speaking skill can improve the students' presentation skills.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	10	33.33	33.33
Agree	14	46.67	46.67
Neutral	3	10.00	10.00
Disagree	2	6.67	6.67
Strongly disagree	1	3.33	3.33
Total	30	100.00	100

Table (5) underscores CALL's vital role in improving EFL students' speaking and presentation skills, with (80%) of respondents affirming its positive impact. CALL is viewed as essential for preparing academic tasks like presentations, debates, and seminars. With appropriate guidance and practice, students can overcome anxiety and become confident communicators. Overall, the findings reflect strong support for CALL's effectiveness in enhancing academic communication and presentation proficiency.

Table (6) Learning speaking through CALL based instructions gives students positive attitude towards the speaking skill.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	9	30.00	30.00
Agree	11	36.67	36.67
Neutral	5	16.67	16.67
Disagree	4	13.33	13.33
Strongly disagree	1	3.33	3.33
Total	30	100.00	100

Table (6) highlights that (66.67%) of respondents hold a positive attitude toward CALL-based speaking instruction. Most of the participants (66.67%) clearly hold a positive view regarding the impact of CALL-based instruction on students' attitudes towards speaking skill. This positive attitude is crucial for language learning, as a student's motivation and confidence directly impact their willingness to practice and improve speaking skill.

Table (7) EFL teachers no longer see themselves as controllers of knowledge due to spread of web resources

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	4	13.33	13.33
Agree	5	16.67	16.67
Neutral	8	26.67	26.67
Disagree	8	26.67	26.67
Strongly disagree	5	16.67	16.67
Total	30	100.00	100

Table (7) explores how the expansion of web resources influences EFL teachers perceived role as knowledge controllers. A notable (43.34%) of respondents disagree with the idea that teachers have lost this role, while (26.67%) remained neutral.

Table (8) CALL is used by EFL teachers to create positive class atmosphere at University of Dongola.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	9	30.00	30.30
Agree	10	33.33	33.33
Neutral	6	20.00	20.00
Disagree	3	10.00	10.00
Strongly disagree	2	6.67	6.67
Total	30	100.00	100

As Table (8) shows, most of the participants (63.33%) emphasized that CALL is utilized in English language teaching and learning at the University of Dongola and played a crucial role in education, particularly in English as a Foreign Language instruction.

Table (9) EFL students' motivation increases with the use of web-based materials in the classroom.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	7	23.33	23.33
Agree	12	40.00	40.00
Neutral	6	20.00	20.00
Disagree	2	6.67	6.67
Strongly disagree	3	10.00	10.00
Total	30	100.00	100

Table (9) illustrates the use of web-based materials in EFL classroom to increase students' motivation. The results reflect that most of the participants (63.33%) of EFL students' motivation increases with the use of web-based materials.

Table (10) Teachers who know the usage of CALL applications have advantages over teachers who do not.

Valid	Frequency	Percent	Cumulative Percent
Strongly agree	9	30.00	30.00
Agree	13	43.33	43.33
Neutral	4	13.33	13.33
Disagree	2	6.67	6.67
Strongly disagree	2	6.67	6.67
Total	30	100.00	100

As shown in table (10) The results reflect that two-thirds of the participants (73.33%) strongly emphasized that EFL teachers who are knowledgeable in using CALL applications are perceived to have significant advantages over those who lack such expertise. The results reflect a widespread understanding that CALL proficiency equips teachers with valuable tools and skill that enhance their teaching capabilities.

Teachers' Responses to Open Questionnaire Question:

This section summarizes university teachers' insights on using CALL to enhance EFL students' speaking skills. Teachers identified major challenges such as limited tech access, poor training, and institutional resistance. They emphasized the need for digital literacy, budget allocation, and critical thinking to overcome these barriers. Proposed solutions included mobile apps, online libraries, AI-powered tools, and collaborative CALL activities. Interactive methods like audio forums, video conferencing, and voice-annotated documents were seen as effective strategies. These collaborative strategies aim to shift CALL from a passive tool to an active learningenvironment that fosters peer interaction.
Teachers emphasized that integrating CALL with structured speaking tasks can bridge gaps in fluency, confidence, and classroom engagement.

Analysis of the Pre-test and Posttest:

The researcher used pre-test and post-test tools to assess CALL's impact on EFL students' speaking skills. Each test included four sections targeting pronunciation, fluency, vocabulary and grammar, and oral presentation. The data were analyzed using SPSS to evaluate performance improvements and verified the study's hypotheses.

Table (11) Analysis of the Students' Pre-test

Skill	Pass	Fail	Total	Percent
Pronunciation	33	67	100	33.0%
Fluency	41	59	100	41.0%
Vocabulary	46	54	100	46.0%
Grammar	26	74	100	26.0%
Oral Presentation	47	53	100	47.0%
Total	193	307	500	38.6%

Pronunciation:

The above table shows (67%) of students failed due to poor articulation and intonation, revealing a major weakness in phonetic accuracy. This highlights the need for targeted CALL interventions to improve pronunciation proficiency.

Fluency:

The table also shows (59%) of students struggled with smooth, continuous speech, often pausing or hesitating during expressions. Their lack of rhythm and frequent word-finding issues indicate a critical gap in spoken fluency.

Vocabulary:

Most of the students (54%) failed to demonstrate adequate lexical range, often repeating words or pausing to search for them. Despite being the second strongest area, vocabulary limitations still hinder confident speech delivery.

Grammar:

Grammar was the weakest sub-skill, with (74%) failing due to errors in tense,

articles, and subject-verb agreement. These persistent issues suggest a need for structured grammar-focused CALL activities.

Oral Presentation:

Most of the students (53%) failed in presentation skills, struggling with pronunciation, vocabulary, and grammar integration. Their performance was affected by anxiety and lack of coherence, requiring holistic CALL-based support.

Table (12) Analysis of the Students' Posttest

Skill	Pass	Fail	Total	Percent
Pronunciation	71	22	93	76.34%
Fluency	68	20	88	77.27%
Vocabulary	86	14	100	86.0%
Grammar	76	24	100	76.0%
Oral Presentation	75	23	98	70.40%
Total	376	103	479	77.24%

After 8-week CALL-based intervention using online classes, WhatsApp chats, websites, and social media platforms, the sample of the study showed marked improvements in speaking skills. A total of (77.24%) of the students passed the post test. The details are as follow.

Pronunciation:

(76.34%) of the participants passed the post test, showing improved clarity, correct phoneme production, and effective use of stress and intonation. CALL tools helped students articulate sounds more accurately and confidently.

Fluency:

(77.27%) of the participants succeeded in maintaining natural rhythm, connected speech, and automaticity. The intervention enhanced their ability to speak smoothly and link ideas without hesitation.

Vocabulary:

This was the strongest sub-skill, with 86% of the students passed. Students demonstrated a broad lexical range, precise word choice, and improved expression, supported by vocabulary-building exercises and digital resources.

Grammar:

The majority of the students (76%) passed, showing mastery in sentence structure, verb tenses, subject-verb agreement, and syntax. CALL tools and guided websites effectively addressed pre-test grammar weaknesses.

Oral Presentation:

Most of the students, (76.53%) passed, though it remained the most challenging sub-skill. The improvements were noted in pronunciation, vocabulary, and grammar integration, aided by CALL tools like voice recordings, imitation apps, and interactive platforms.

Table (13) Comparison between the Pre-test and Posttest

Pair	Comparison	Mean	Std. deviation	Std. error Mean	t-value	df	Sig. (2-tailed)
1	Pass in pretest	68.2	10.5	1.05	17.33	99	<0.0001
2	Pass in posttest	85.4	8.8	0.88	40.23	99	<0.0001
	Difference (Post - Pre)	-17.2	4.2	0.42	-7.14	99	0

The results shown in table (13) indicate a highly significant improvement in scores from pretest to posttest. The intervention and instructional activities using CALL appears to have had a strong positive effect on students' performance. The paired-sample t-test evaluated the effect of the intervention on students' test performance. The results indicated a statistically significant improvement in scores from the pretest (M = 68.20, SD = 10.50) to the posttest (M = 85.40, SD = 8.80), with a mean difference of -17.20 (SE = 0.42), t(99) = -7.14, p < .001. This suggests that the intervention had a substantial positive impact on students' performance.

Discussion of the Results:

Hypothesis (1): Using CALL in language learning can improve students' speaking skill at University of Dongola.

The results of the questionnaire and the pre/posttests reveal that using of CALL in language instruction in EFL classroom can improve students' speaking skill at University of Dongola. This appears in table (2), which shows the significance of exploiting CALL in improving EFL students' speaking skill. The table shows (53.33%) of the participants' responses indicate the importance of using CALL in increasing students' production of the spoken utterances. Moreover, the results of the tests affirm that exploiting CALL programs and tools inside EFL classroom has positive impact on enhancing students' speaking skill.

In the analysis of the posttest, students' speaking skill has improved effectively after the period of treatment. This appears clearly in the analysis of table (8), and goes in line with the study of Muhammad Imran and Khaliq Bashar (2022) who found that the experimental group outflanked the control group in both speaking and vocabulary posttests.

Hypothesis (2): Adopting of CALL inside classroom increases motivation of EFL students at University of Dongola.

The adoption of Computer-Assisted Language Learning (CALL) in the classroom generally increases the motivation of EFL students. The analysis of the questionnaire and the posttest supports this hypothesis. Table (6) shows the students' positive perception of learning speaking through CALL based instruction. In the analysis of the above table most of the respondents (66.37%) confirmed the impact of CALL-based instructions on students' perception towards speaking skill. This positive perception is crucial for language learning as a student's motivation and confidence directly impact their willingness to practice and improve speaking skill. This result is supported by the study conducted by Ahmed Sabri Bushra and Sunil (2020) who investigated Yemeni EFL Students' perceptions and implementation of Computer -Assisted Language Learning. The outcomes of their study revealed that the participants perceive CALL positively (overall mean = 4.1144 out of 5) and believe in its effectiveness in developing their language skills and making their EFL learning enjoyable and interesting.

Hypothesis (3): EFL students at the University of Dongola with varying learning styles benefit from the use of CALL.

Different of learning styles are shown in EFL classroom while using computer assisted language learning**. i**n the analysis of table (2), which shows the significance of exploiting CALL in improving EFL students' speaking skill. The majority of the participants (83.33%) assures the presences of different learning styles while using CALL. They emphasized its importance in increasing students' production and comprehension of the spoken language. Beside its benefit in improving speaking skill, computer assisted programs can be an appropriate instrument to offer useful classroom learning styles.

This hypothesis was also supported by the analysis of the posttest. In the analysis of table (12), EFL students' performance was improved after the intervention period. When assessing students in the sub-skills of speaking, different learning styles were shown. Its results appeared in the analysis of the sub-skills as follow;

In pronunciation, most of EFL students produced sounds in the posttest in a way that is understandable, clear, and correct. In fluency, EFL students could construct sentences correctly, link words and phrases together effectively. They made their speech sound more natural.

In grammar, EFL students seemed to have a good command of English grammatical structures. They formed sentences that are syntactically correct and convey the intended meaning.

In oral presentation, the analysis indicates that oral presentation was achieved through different learning styles. Learning through CALL tools are crucial in this sub-skill where students' performance could be most significantly improved. These findings are in agreement with Naiyer Azam Hashmi (2016) in his investigation of how Computer Assisted Language Learning (CALL) has attracted many Arab students in learning English as a foreign language in Najran university, Saudi Arabia. He found that as a response to the students' attraction in CALL, computer technologies have been brought into classrooms where they are considered to be effective in enhancing students learning and addressing certain education problems.

Conclusion, Findings and Recommendations:

This section summarizes the key outcomes and practical insights derived from the study, detailed description of the major findings and recommendations to guide future practice.

Conclusion:

The study is intended mainly to investigate the impact of computer assisted language learning (CALL) on enhancing EFL students' speaking skill. The use of computer technology for teaching, learning, and practicing speaking skill has many advantages for EFL students in Sudanese universities, particularly, for the students who are majoring English language in the University of Dongola, where EFL students get very few opportunities for practicing and assessing their speaking skill. The integration of computer technology into language education offers several advantages for developing speaking skill. It provides students with access to authentic, real-world content, such as podcasts and news clips. It allows them to hear how the language is used naturally.

In addition to that, technology enables personal practice, self learning, giving students the ability to record themselves and receive instant feedback on their pronunciation and fluency. If EFL teachers and learners wisely capitalize upon these positive aspects of the use of computer technology in EFL instruction while teaching, learning and practicing a target language, the results would be highly encouraging, productive, profitable and can be attained very easily.

Findings:

There are many findings obtained from the statistical analysis of the teachers' questionnaire and pre/posttests. They are as follow:

1. CALL saves time effectively if used by EFL teachers in teaching speaking skill.
2. CALL in EFL instruction provides multisensory speaking learning environments and styles.
3. Exploiting CALL in EFL classroom is beneficial for improving and practicing the speaking skill among EFL students.
4. The use of CALL increases students' participation in various classroom activities.
5. Applying CALL increases interaction in the classroom and provides more active role in teaching and learning speaking skill.

Recommendations:

Based on the findings regarding the use of Computer-Assisted Language Learning (CALL) for improving EFL students' speaking skill, the following recommendations are proposed to effectively integrate this technology into educational practices:

1. EFL teachers and students should have considerable knowledge and training in CALL use.
2. EFL teachers should incorporate Computer-Assisted Language Learning (CALL) tools into speaking skill teaching and learning to enhance time efficiency.
3. EFL teachers and students should utilize CALL platforms that support audio, visual, and interactive elements to create rich environments for speaking practice.
4. Sudanese universities and institutions should support the use of CALL to facilitate speaking skill practice, improving fluency and confidence among EFL students.
5. EFL teachers should focus on teaching speaking skill using CALL tools more than traditional teaching methods.

Suggestions for Further Studies:

1. A Longitudinal Study on the Long-Term Effects of CALL on Speaking Proficiency
2. Investigating the Efficacy of Specific CALL Tools on Different Components of Speaking
3. Exploring the Relationship Between CALL and Students' Affective Factors

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Agricultural Extension Workers' perceptions of Participatory Approach for Rural Development in Sudan

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Abstract:

Perceptions are important determinants of human behavior. This statement reflects the importance of understanding extension workers' perception regarding participatory extension approach practices. Participatory approaches can increase the number and diversity of people able to participate in decision-making and integrate experts and local knowledge**.** The objective of this research is to assess the perception of extension workers of the participatory approach in Gezira, Sinnar and Gedarif States in Sudan. The paper aims to determine the socio-economic characteristic, identify primary responsibilities of extension workers, and find out extension approaches and methods which are practiced in Sudan. The paper accounts for extension workers' perception of the participatory approach. It depended on collection of data from a sample of 205 extension workers, representing 97.5 % of the state's extension workers by means of a questionnaire and secondary data used from relevant sources. The analysis of primary data was performed by using the Statistical Package for Social Science (SPSS). The results showed that agricultural extension workers in the three studied states were mostly middle-aged, 82.4% male, 82% had over 5 years of experience, and had positive perceptions toward the participatory approach. Their perceptions did not significantly differ with gender, age, years of experience, level of education, and attendance of training programs. The results indicate that the respondents are highly interested in implementing the participatory approach and expect that the participatory approach will be targeted towards the empowerment of local farmers. The farmers would have an opportunity to participate in decision-making and working relationships. This study offers valuable insights to comprehend agricultural extension workers' perceptions of the participatory approach, which could enhance the effectiveness of extension services.

Key words: Agricultural extension, participatory approach, rural development, Sudan.

مستخلص:

يُعد الادراك من العوامل المهمة المُحددة للسلوك البشري. يعكس هذا البيان أهمية فهم تصورات العاملين في مجال الإرشاد الزراعي فيما يتعلق بممارسات النهج الإرشادي التشاركي. يُمكن للنهج التشاركي أن يزيد من عدد وتنوع الأشخاص القادرين على المشاركة في صنع القرار ودمج الخبراء والمعرفة المحلية. تهدف الدراسة إلى تقييم تصور العاملين في مجال الإرشاد للنهج التشاركي في ولايات الجزيرة وسنار والقضارف في السودان. تهدف الورقة إلى تحديد الخصائص الاجتماعية والاقتصادية، وتحديد المسؤوليات الأساسية للعاملين في مجال الإرشاد، ومعرفة مناهج وأساليب الإرشاد المُمارسة في السودان. وقد اعتمدت على جمع البيانات من عينة من 205 عاملين في مجال الإرشاد، يمثلون 97.5٪ من العاملين في مجال الإرشاد في الولاية عن طريق استبيان وبيانات ثانوية مستخدمة من مصادر ذات صلة. تم إجراء تحليل البيانات الأولية باستخدام الحزمة الإحصائية للعلوم الاجتماعية (SPSS). أظهرت النتائج أن العاملين في مجال الإرشاد الزراعي في الولايات الثلاث المدروسة كانوا في الغالب في منتصف العمر، 82.4٪ من الذكور، 82٪ لديهم خبرة تزيد عن 5 سنوات، وكان لديهم تصورات إيجابية تجاه النهج التشاركي. لم تختلف تصوراتهم اختلافًا كبيرًا باختلاف الجنس والعمر وسنوات الخبرة والمستوى

التعليمي وحضور البرامج التدريبية. تشير النتائج إلى اهتمام المشاركين الكبير بتطبيق النهج التشاركي، وتوقعهم أن يستهدف تمكين المزارعين المحليين، وأن تُتاح لهم فرصة المشاركة في صنع القرار وبناء علاقات العمل. تقدم هذه الدراسة رؤى قيّمة لفهم تصورات العاملين في الإرشاد الزراعي للنهج التشاركي، مما قد يُحسّن فعالية خدمات الإرشاد.

Introduction:

Agriculture in Sudan plays a fundamental role in economic growth, poverty reduction, food security, environment and rural development. Most of the population lives in rural areas and principally work in agriculture for their livelihood. (Adam *et al*., 2018; DeLancey. 2015). Extension is an educational tool that can make a fundamental contribution to sustainable development in the agricultural sector (FAO, 1997). Agricultural extension is an efficient and systematic process that helps rural farmers to help themselves by informing them and improving their knowledge and skills on how to increase their production in terms of applying useful information and technology in their farming practices (Baig and Aldosari, 2013, Al-Doski and HamaSalih, 2017). Extension is a system that helps farmers to develop their practices and skills (Christoplos, 2010). Extension service access encourages the use of advanced agricultural technologies by reducing supply side constraints caused by inefficient information markets (Wossen *et al.,* 2015). Agricultural extension systems must be structured to assist farmers in developing their agricultural competence and connect efficiently with producers (Altalb *et al.,* 2015). Extension workers play a crucial part in promoting farmers to be involved in development programs (Aremu *et al.,* 2015). Top-down agricultural extension programs have failed to raise agricultural production in Sub-Saharan Africa (Rivera, 1997, 2001). Top-down approach often failed to consider the farmers' local knowledge and specific needs, leading to low adoption rates of new agricultural practices that calling for more inclusive and participatory approaches to enhance engagement and adoption (Parvez *et al.*, 2023). Today, support for developing countries is centred around the Sustainable Development Goals (SDGs) and agricultural extension has shifted to comprehensive services with a bottom - up approach with the involvement of diverse players, including the government, private companies and non-governmental organizations (NGOs) (FAO, 2019). Participatory extension approaches will become more important. A participatory learning process needs to be incorporated where farmers and other development beneficiaries have real decision-making power and are part of the problem analysis and solution generation (Elliot and Martin 1995; Roling and Pretty, 1997). Extension workers recently have played the role of facilitator (Hagmann *et al*. 1998, Anandajayasekeram *et al.* 2008). Shifting the focus from teaching to facilitating from hierarchical, top-down to participatory bottom-up approaches, from centralized to decentralized decision-making will put institutions under pressure for change as well. Thus, governmental and non-governmental organizations are important actors in the learning process (Hagmann *et al*. 1999). The transfer of technology approach revealed that the links between farmers, extensionists, and researchers have been very weak or missing (Anderson and Feder, 2004). Participatory extension approach is a method of enhancing the efficiency of extension endeavor by NGOs, government agencies, and other organizations (Hagmann *et al,* 1999). The extension participatory approach is focusing on small-scale farmers and the rural poor of the society as major targets through their groups and organizations rather than as individuals for the purposes of achieving progress and development in all aspects of their life (Alsffar *et al.,* 1997). Participatory approaches motivate rural people to participate in development plans and policy decision-making processes (Ako, 2017). Studies indicate that extension workers who embrace farmer participation achieve more sustainable and impactful outcomes (Davis, 2008). The aims of this research are to determine the socio-economic characteristic of the respondents, identify primary responsibilities of agricultural extension workers, find out extension approaches and

methods which are practiced in Sudan and assess the level of knowledge of extension workers for the participatory extension approach.

Methodology:

Area of the study:

The research was performed in three states of Sudan; namely, Gezira, Sennar and Gadarif, which have large agricultural zones, and situated between latitudes 22° N - 12° S and 36°E - 27°W and high population densities. They represent the main agricultural production areas in Sudan. Furthermore, the number of farmers and extension staff working in selected states is higher than in other states.

Population of the study:

The population of the research includes the extension workers in Gezira, Gadarif and Sinnar states. The survey covered two hundred and five extension workers working in three states in their localities. They equal 97.6% from the total population. Although the original strategy was to interview all extension workers in the study area with 210 extension workers (80 in Gezira, 58 in Sinnar, and 72 in Gedarif), due to different reasons, five extension workers were not available at the time of the survey.

Data collection:

The research mostly depended on primary data that was collected from the three areas of the study using questionnaire. The questionnaire was pre-tested on a sample of 30 extension workers out of the study population of extension samples to assure that it has a high extent of reliability and validity. In addition, secondary data was collected from relevant sources.

Analysis of data:

The aim of the analysis was to test the hypotheses, different techniques exploited to analyze the collected data. The SPSS program was used to accomplish the techniques of descriptive statistics (frequency distribution) to calculate the frequency, percentage, mean and standard deviation of each item in frequency matrix. Also, Chi-square test was used to identify relationships between some selected variables and their significance.

Results and Discussion:

Personal Characteristics of Extension Workers:

Gender

The extension workers in the study were 205 individuals, of these 169 were males (82.4%) and 36 were females (17.6%). This finding implies the necessity of analyzing gender balance and gender issues and identify number of female extension workers in federal and state extension systems, also determine female farmers' access to agricultural extension services in Sudan. Furthermore, the agricultural extension programs and mechanisms that are targeted to the needs of female farmers.

Age category:

Table 1. reflected that 44.9% of the extension workers fall in the age category ranging between (30-39) years, and 30% ranging between (40-49) years, moreover, there were about 15.6% of the respondents their age between (50-59) years.

Thus, the general conclusion revealed 74.9% of the whole respondents have ages between (30-49) years. This indicated that most of the extension workers were young. Being young can ensure the availability of good opportunities to benefit from their efforts to build up the rural communities. Working in rural areas needs much energy to move long distances and to exert more efforts to defeat the difficulties. The present findings are in accordance with those of (**Seafeldin, 2012**).

Table 1: Distribution of respondents by age categories

Age in year	Freq.	%
20-29	9	4.4
30-39	92	44.9
40-49	63	30.7
50-59	32	15.6
60 and more	9	4.4
Total	205	100%

Source: Ministry of agriculture Gezira, Sinnar and Gedarif states.

Level of education

Table 2. shows that most extension workers (86.3%) were university graduates, and they hold bachelors. 8.3% of respondents had master's degrees and only about (5.4%) extension workers had diploma. The findings of educational levels indicated that the sample included highly educated extension experts by providing training sessions for extension workers to raise their extension capacity, especially in the field of teaching, for better educational performance.

Table 2: Distribution of respondents by educational qualification

Education levels	Freq.	%
Diploma	11	5.4
Bachelors	177	86.3
Master	17	8.3
Ph.D.	0.0	0.0
Total	205	100

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

Experience in Extension Work:

Table 3. illustrates years of experience of (29.3%) of the respondents was between (10-14) years, (26.3%) of respondents was between 5-9 years, while the experience of (18%) was less than 4 years and (19%) had greater than 20 years. Thus, the results of the table (3) showed that 82% of the respondents had above 5 years of experience. This implies that their level of experience is good, and they were able to perform their roles well.

Table 3: Distribution of respondents by years of experience:

Experience (years)	Freq.	%
Less than 4 years	37	18
5-9	54	26.3
10-14	60	29.3
15-19	15	7.3
More than 20 years	39	19
Total	205	100%

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

Extension Approaches and Methods:

Application of Extension Approaches:

As revealed in Table 4., the practicing of different approaches in the study areas was about 45.9% by the Conventional Agricultural approach. 75.1% by the approach of visit and training. 12.7% by the Commodity Development and 66.35% by the Participatory extension approach. This implies that with little efforts from extension managerial planners, the participatory extension approach can be executed well in the area of study. Consequently, the percentage of farmers' participation in extension service, identification of their needs and problems and their productivity will be increased. The table indicated that the level of implementation of participatory extension approach is (66.3%) this necessitates the importance of raising this level to increase the benefit from this approach. The importance of implementing this approach is to

raise the efficiency of extension works to improve the productivity of the farm. This agreed with those of (**Feder, 2003**).

Table 4 : Practice of extension approaches

Approach	Freq.	%
Conventional agricultural	94	45.9
Training and visit	154	75.1
Commodity development	26	12.7
Participatory extension	136	66.3
Total	205	100

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

Application of Extension Methods:

Many extension methods (individual and group methods) failed because of the many limitations and constraints in the extension work. The responders were questioned to express the different extension methods of their practice. The responses of respondents are presented in Table 5.

Table 5: Opinions of respondents on practicing extension methods:

Methods	practiced		Not practiced	
	Frequency	%	Frequency	%
Farm and home visits	188	91.7	17	8.3
Group meeting	139	67.8	66	32.2
Conducting training for farmers	78	38.0	127	62
Farmers' visits to office	128	62.4	77	37.6
Methods/results demonstrations	92	44.9	113	55.1
Television	63	30.2	142	69.8
Radio	91	44.4	114	55.6
Pamphlets extension	109	53.2	96	46.8
Posters	59	28.8	146	71.2

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

The results in Table 5 revealed that of respondents used farm and home visits, Group meeting, conducting training for farmers, farmers' visits to the office, and Methods/results demonstrations were 91.7, 67.8, 38.0, 62.4, and 44.9% respectively. Practicing extension methods by Television & Radio, the extension workers broadcasting information, e.g. (pest control, improved seeds). These two methods received (30.2%) (44.4%) of respondents respectively. For pamphlets extension, crop production technologies, crop varieties can be distributed through the pamphlets to farmers during the crop season. And for the posters, the extension workers organize the erecting of billboard posters on roads where it can be easily seen by farmers, e.g. (high yielding crops production). This method received (28.8%) of respondents.

It is clear that farm and home visits were favored (91.7%), however, the use of group meeting, conducting training for farmers, method/results, group extension methods demonstrations were so weak because of the lack of facilities to use them.

The results revealed that most (91%) of the respondents used farm and home visits methods to provide agricultural extension services to farmers and their families. This implies that extension workers were well able to identify farmers' needs and problems and find suitable solutions. Also (67.8%) of the respondents used group meetings. This indicated that extension workers were capable to hold discussion with farmers and their families to discuss their needs and problems and come up with good solutions and recommendations regarding these problems with participation of farmers. As reflected in this table (62.4%) of the respondents used farmers' visit office. This means that respondents were enough qualified to discuss with farmers regarding their needs and problems and provide them with suitable information when they visit extension offices.

Primary Responsibilities of Extension Staff:

Table 6 indicated that the most two important responsibilities for extension workers are 'special crop production' and 'crop demonstration' these two items reported highest mean scores 3.89, 3.66 respectively. Workers reposed that special crop production program as their most important function. Crop demonstration was ranked as the second most important, reflecting that extension workers are responsible for managing demonstration plots and trails at farmers' fields and encouraging advanced farmers to inspect such plots and trail. The moderately mean values 3.63, 3.48, 3.46 respectively received by 'writing reports and records', 'rural community development' and 'collecting research data& agricultural information'. Also responses of workers reveal that they are responsible for writing reports about their performance of extension activities, field visits, field days, seasonal crop cultivation, methods used and harvesting processes. Extension workers responsible for cooperating in rural community development activities. Also, the responses of extension workers indicated that they are responsible for collecting research data and agricultural information.

The lowest mean scores reported by 'assisting farmers' credit' (3.45) and 'assisting farmers with marketing of farms products' (3.20). This deduces that these two functions are not important for extension workers because these are not the direct concern of extension workers, although they provided some assistance in these issues.

These results emphasize that most extension workers were occupied with many responsibilities which negatively affected on performance of important extension activities.

Table 6: Opinions of extension workers on their primary responsibilities N=205

Statements	Very important	Moderate important	Less important	Not at all important	Mean	Standard Deviation
Special crop production	90.2	8.3	1.5	0.0	3.89	0.36
Crop demonstration	72.7	21.5	5.4	0.5	3.66	0.60
Writing reports and records	69.8	23.9	5.9	0.5	3.63	0.62
Rural community development	58	33.7	6.8	1.5	3.48	0.69
Collecting research data &agricultural information	58	32.7	6.3	2.9	3.46	0.74
Assisting farmers credit	66.5	28.3	7.3	3.9	3.45	0.79
Assisting farmers with marketing of farm products	47.3	33.7	10.2	8.8	3.20	0.95

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

Factors Affecting the Performance of Extension Work:

Table 7 shows that the highest mean score reported by 'farmer's inadequate technical package in agriculture' (3.69), 'lack of suitable market and price for farm products' (3.69), 'problems of irrigation and rains' (3.67), 'poor transportation facilities' (3.66), 'lack of farmers' finance' (3.62). The moderately mean values (3.54) (3.52) were received by 'no insurance for crop damage' and 'lack of proper extension programs for the needs of the local community' respectively. 'Weak participation of local people in developmental programs', 'responsibility for research experiments', 'inadequate extension workers' and 'too many farmers' recorded the lowest mean scores 3.35, 3.26, 3.20 and 3.18 respectively.

The results from Table 7 indicated that all statements listed in this study were identified as the main factors for extension work to make good contact with farmers.

Farmers' inadequate technical package was a strong hindering factor for extension workers in performing extension activities because the programs concentrate on new technology. Price assurance and the shortage of proper markets for production and no insurance for crop damage; sometimes farmers face disasters like flooding, disease, drought, infection, and insect

infestation. There is a lack of finances, most farmers are poor, and credits for the farmers are very small when compared to the high production cost. Insufficient extension workers, too many farmers, and lack of transportation are also obstructing factors for workers, extension workers could not reach a large percentage of farmers.

In promoting the development of agricultural extension, there is a greater need to assess the needs and opportunities of current agricultural extension work.

Table 7: Perceptions of extension workers on factors affecting the performance of extension work

Statements	Strong hinder	Moderate hinder	Little hinder	No hinder	mean	Standard Deviation
Farmers inadequate technical knowledge in agriculture	78	16.1	2.9	2.9	3.69	0.67
Lack of suitable market and price for farm products	72.7	23.9	2.9	0.5	3.69	0.55
Problems of irrigation and rains	73.2	21.0	5.9	0.0	3.67	0.58
Poor transportation facilities	71.7	23.9	3.4	1.0	3.66	0.59
Lack of farmers finance	68.8	26.3	3.4	1.5	3.62	0.63
No insurance for crop damage	61.5	32.7	3.9	2.0	3.54	0.67
Insufficient number of suitable extension programs.	62.9	27.8	7.8	1.5	3.52	0.70
Weak participation of local people in developmental programs	43.9	47.3	8.3	0.5	3.35	0.65
Responsibility for research experiments	43.9	41.5	11.2	3.4	3.26	0.79
Inadequate extension workers	44.4	39.5	8.3	7.8	3.20	0.89
Too many farmers	44.4	38.0	8.8	8.8	3.18	0.92

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

Knowledge of Workers on Extension Approaches:

In order to investigate the perception of extension workers on the practicing extension approaches (the conventional agricultural approach, the commodity approach, the visit and training approach, and participatory extension approach), workers were asked questions concerning the concepts, the key features and typical characteristics of these approaches. All the typical characteristics for the four approaches were mixed and each respondent was asked the question.

Participatory Extension approach:

To determine the knowledge of extension workers pertaining to the participatory extension approach, each respondent was questioned: What are the key features of the participatory approach and the typical characteristics of the participatory approach?

The responses of extension workers on the key features of participatory extension approach are presented in Table 8.

Table 8: Responses of extension workers on the key features of the participatory extension approach (N=205)

Key features	Strongly agree	agree	disagree	mean	Standard Deviation
They support smallholder to learn through experimentation, building on their knowledge and practices and blending them with new ideas	66.4	31.2	2.4	2.64	0.53

It makes monitoring and evaluation of extension program.	60.5	35.6	3.9	2.57	0.57
The main aim is to strengthen rural people's management abilities, planning, and resolving problems.	60.0	34.6	5.4	2.55	0.60
They combine community mobilization for action with rural development, agricultural extension, planning, and research	59.5	33.7	6.8	2.53	0.62
It encourages both demonstrative and competition between different production areas	56.1	39.5	4.4	2.52	0.58
They are dependent on an equal partnership between extension workers, researchers, and farmers.	54.6	39.1	6.3	2.48	0.62
It makes selection crop, extension personnel and management	55.1	36.6	8.3	2.47	0.65
Organization of farmers into groups of 100 farmers of each one.	56.1	34.6	9.3	2.47	0.66
It makes effective linkages between research, extension and farmers	49.3	44.8	5.9	2.43	0.60
The main aim is transferring the proven new technology	55.1	31.2	13.7	2.41	0.72
There is governmental support (credit)	34.2	39.5	26.3	2.08	0.78
It executes commands in one direction	16.6	30.7	52.7	1.64	0.75

Source:Ministry of agriculture Gezira, Sinnar and Gedarif states.

The first six items in Table 8. reported the highest values. The results from the table indicated that extension workers have a good understanding of key features for participatory approach. The answers of extension workers on the typical characteristics of the participatory extension approach are presented in Table 9.

Table 9: Responses of extension workers on the typical characteristic for the participatory extension approach (N=205)

Statement	Strongly agree	agree	Disagree	mean	Standard Deviation
It is a continuous process of learning and exchange of knowledge among the stakeholders in rural areas	49.3	42.9	7.8	2.41	0.63
Farmers use methods, apply principles, and choose from basket and experiment	48.3	40.5	11.2	2.37	0.68
The roles of extension workers are as facilitator and provider	45.4	42.0	12.6	2.33	0.69
It is a bottom-up approach	41.0	37.5	21.5	2.20	0.77
The menu is according to farmer choice	34.2	42.4	23.4	2.11	0.75
It is a decentralized decision making	38.0	33.7	28.3	2.10	0.81
The roles of extension workers	32.2	43.4	24.4	2.08	0.75

are as teacher and trainer					
Main mode of message is from farmer to farmer	33.7	39.5	26.8	2.07	0.78
It is a highly centralized administrative systems	31.7	41.0	27.3	2.04	0.77
Main mode of message is from extension workers to farmers	26.8	42.4	30.8	1.96	0.76
Farmers hear messages, act on commandments, and adopt package	23.4	43.9	32.7	1.91	0.75
Crop production is oriented under the pressure of production target	26.3	37.1	36.6	1.90	0.79
The menu is fixed	18.5	37.1	44.4	1.74	0.75
It is a top-down approach	23.9	25.9	50.2	1.74	0.82
It is subjected to great political pressure	20.5	27.3	52.2	1.68	0.79

Source: Ministry of agriculture Gezira, Sinnar and Gedarif states.

15 items instrument was used to recognize extension workers' perceptions of participatory extension approach. Of these 7 items of the instrument were positive while the remaining 8 items were negative of participatory extension approach.

The first 7 items in Table 9. received high mean scores. The findings from the table indicated that the extension workers had a positive perception toward a participatory extension approach. Chi-square test for an independent sample revealed that agricultural extension workers' perceptions did not differ significantly with their age, gender, levels of education, experience and training programs, (Tables 12-16).

Agricultural Training:

Table 10 reflected that ‘principles of participatory learning and action’ and ‘participatory extension methods’ received the highest mean scores of 3.69 and 3.63 respectively. These were followed by ‘how to conduct a participatory workshops’ and ‘concepts of participatory extension approaches’ receiving the moderately mean scores 3.56 and 3.55 respectively. The lowest mean values were reported, respectively, how to conduct a participatory course (3.48), how to knowledge for farmers' experience (3.41), how to conduct a participatory research (3.40).

The results from this table indicated that all training topics identified in this study were considered by the majority of respondents to be very important for extension workers.

It is clear that respondents have not enough knowledge and information about the participatory extension and they indicated their needs for participatory training in all identified areas in this study.

Table 10: Perceptions of extension workers towards their needs for participatory training

Topic of training	Number of respondents (N-205) Degree of importance				Mean	Standard Deviation
	Very	moderate	less	not at all		
Principles of participatory learning and action	72.7	24.4	2.0	1.0	3.69	0.56
Participatory extension methods	67.8	29.3	1.5	1.5	3.63	0.59
How to conduct a participatory workshops	65.9	26.8	4.9	2.4	3.56	0.70

Concepts of participatory extension approaches	60.5	35.1	3.4	1.0	3.55	0.61
How to conduct a participatory courses	60.5	28.3	9.8	1.5	3.48	0.73
How to knowledge for farmers experience	63.4	23.4	4.4	8.8	3.41	0.93
How to conduct a participatory research	51.2	39.5	6.8	2.4	3.40	0.72

Source: Ministry of agriculture Gezira, Sinnar and Gedarif states.

Participation between Extension Forkers and farmers:

The data in Table 11 reveal that 'extension programs implementation' reported the highest mean score of 3.52. The moderate mean value 3.33 was recorded for the stage 'extension programs monitoring'. 'Extension programs planning' and 'extension programs evaluation' received the lowest mean score 3.10.

Participation of farmers and extension workers in extension program planning always assist in promoting extension service. When extension workers lay out extension plans, they consider farmers' needs and problems. On the other hand, each one gains other experiences. Other factors include decentralizing activities and facilitating to apply local groups, increase farmer participation in sustainable agricultural development programs and agricultural extension services, are the essential approaches for agricultural extension in future (**Allahyari, 2009**). To achieve educational goals when working with farmers as adults, extension workers must be aware of the principles of adult education, mainly the principles of participation as one of the psychological principles in adult education. Extension workers must be capable enough to use bottom-up approach to identify farmers' needs and priorities and consider them when designing extension plans, implementation, monitoring and evaluation.

Table 11: Participation between extension workers and farmers (N – 205)

Stage	Always	Sometime	Few	Nothing	Mean	Standard Deviation
Extension programs implementation	67.3	21.0	7.8	3.9	3.52	0.80
Extension programs monitoring	53.7	31.2	9.8	5.4	3.33	0.86
Extension programs planning	38.0	42.4	11.2	8.3	3.10	0.90
Extension programs evaluation	47.3	25.9	16.6	10.2	3.10	1.02

Source: Ministry of agriculture Gezira,Sinnar and Gedarif states.

Chi-square test results of agricultural extension workers' perception of participatory approach by some variables

The chi-square test results in Table 12, showed that agricultural extension workers' perception of participatory approach was not significantly associated with gender.

Table 12: Chi-square test of extension workers' perception of participatory approach by Gender

Perception level	Gender		Total
	Male	Female	
No	62 91.2%	6 8.8%	68 100 %
Moderate	84	23	107

	78.5%	21.5%	100%
High	23 76.7%	7 23.3%	30 100%
Total	169 82.4%	36 17.6%	205 100%

Chi-square = 0.67

As illustrated by Table 13, there was no significant association between agricultural extension workers' perception of participatory approach and their age.

Table 13: Chi-square test of extension workers' perception of participatory approach by age

Perception level	Age		Total
	39 years and less	40 years and above	
No	33 48.5%	35 51.5%	68 100%
Moderate	53 49.5%	54 50.5%	107 100%
High	15 50%	15 50%	30 100%
Total	101 49.3%	104 50.7%	205 100%

Chi-square = 0.988

Results of the chi-square test in Table 14 reflected that no significant difference between agricultural extension workers' perception of the participatory approach and educational level.

Table 14: Chi-square test of extension workers' perception of participatory approach by education

Perception level	Education		Total
	Diploma	Doctorate	
No	5 7.4%	63 92.6%	68 100%
Moderate	5 4.7%	102 95.3%	107 100%
High	1 3.3%	29 96.7%	30 100%
Total	11 5.4%	194 94.6%	205 100%

Chi-square = 0.646

The findings of chi-square test in Table 15 showed that there was no association between agricultural extension workers' perception and experience years.

Table 15: Chi-square test of extension workers' perception of participatory approach by experience

Perception level	Experience		Total
	4 years and less	More than 4years	
No	11 16.2%	57 83.8%	68 100%
Moderate	23 21.5%	84 78.5%	107 100%

High	3 10.0%	27 90.0%	30 100%
Total	37 18.0%	168 82.0%	205 100%

Chi square = 0.311

Results of the chi-square test in Table 16, indicated that no significant association between agricultural extension workers' perception of participatory approach and training sessions.

Table 16: Chi-square test of extension workers' perception of participatory approach by training

Perception level	Training		Total
	No training session	Had one and more training	
No	24 35.3%	44 64.7%	68 100%
Moderate	34 31.8%	73 68.2%	107 100%
High	4 13.3%	26 86.7%	30 100%
Total	62 30.2%	143 69.8%	205 100%

Chi-square = 0.82

The study showed that most of workers were male. About three quarters of the extension workers have an age ranging from 30-49 years, while the rest were more than 50 years of age. Most of the workers were university graduates and few of them had master's degree. The majority of the extension workers were married. Years of experience show that most of the agricultural extension workers had over 5 years of experience. The study findings reflected that the important responsibilities of extension workers were special crop production, crop demonstration, writing reports and records, rural community development and collection of data and information. The study results showed that the strong hindering factors of extension workers in performing extension activities were farmers' inadequate technical knowledge in agriculture, lack of suitable market and price for farm products, problems of irrigation and rain, poor transportation facilities and lack of farmers' finance. Agricultural extension workers prefer training by monitoring and evaluation and field demonstrations. The result also emphasized that necessity of building training program based on the needs of trainees.

Extension staff indicated that the principles of participatory learning and action, participatory approach methods, how to conduct participatory workshops and concepts of participatory approach were considered by the majority of respondents to be very important for extension workers, also implies that respondents have not enough knowledge and information about the participatory extension and they indicated their needs for participatory training.

The study noticed that agricultural extension workers participate as farmers in extension program implementation stage and ignoring them in stages of extension program planning, monitoring and evaluation. Extension workers must be capable enough to use bottom-up approach to identify farmers' needs and priorities and consider them when designing extension plans, implementation, monitoring and evaluation.

Conclusions:

The study results showed that the extension workers had a positive perception of participatory extension approach. Their knowledge of participatory approach did not differ with their gender, age, level of education, training program attended, and years of service in extension system. The study findings showed extension workers were very interested in implementing the participatory

approach in agricultural extension services. Also, extension workers expected that the participatory approach could be oriented towards the improvement of local farmers' practices. Farmers would have an opportunity to share in their own decision-making and problem identification processes and relationship between extension workers, farmers, research would be improved and contribute to increasing the sufficiency and effectiveness of extension work. In promoting the progress of extension, there was a greater need to assess the needs and opportunities of current agricultural extension work. Providing suitable transport facilities for reaching farmers' sites and good salary could motivate extension workers. Development of appropriate social and economic research concentrates on issues and conditions and providing training opportunities will be required. To improve performance continuous training will be needed regarding extension methods and contents.

Existence of specific competences among extension workers with great attention to improving and sustaining these competences through availability of training, introducing new task can result in good work performance.

Conflict of Interest: The authors hereby declare that there is no conflict of interest.

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Epidemiological Prevalence and Risk Factors of Hypertension among War Internally Displacement Peoples in Northern State of Sudan, A community-Based Study

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Abstract:

Background: Hypertension is a growing public health concern, especially among vulnerable populations such as internally displaced persons (IDPs). This study aimed to assess the prevalence of hypertension and identify associated risk factors among adult IDPs living in IDPs shelters in Dongola locality, Northern state of Sudan.

Methods: A descriptive cross-sectional community-based study was conducted between December 22, 2023, and January 11, 2024, using a shelter-to-shelter survey in Dongola locality. Informed consent was obtained prior to the commencement of the study. A total of 323 adult IDPs (aged ≥18 years) were selected randomly. Data were collected through face-to-face interviews and physical measurements, including blood pressure, random blood glucose, and anthropometry.

Results: Among the 323 participants (27.5% males; 72.4% females; mean age 39.2±15.9 years), hypertension prevalence was 21.3%, higher in females 23.7% than males 7.1%. A significant proportion had abnormal BMI 90.7%, participants below 50 years old 73%. family history of hypertension 60.9%, diabetes 54.4%, cardiovascular disease 19%, and renal disease 13%. Barriers to medication adherence included financial constraints 10.1%, medication unavailability 7.2%, and lack of motivation 8.8%. Regular doctor visits were reported by 60.8% of hypertensive participants. An education profile of the participants showed that 13.9% are not educated.

- Hypertension showed a statistically significant association with age, where 57.1% of individuals aged 60 years and above were hypertensive ($p < 0.001$). A higher prevalence was also observed among females 22.6% compared to males 7.1%, though this difference did not reach statistical significance ($p = 0.1834$). While no significant association was found with economic status ($p = 0.255$), financial hardship remains a potential barrier to hypertension management in this population.

Conclusion: Hypertension prevalence among IDPs living in displacement shelters in Dongola locality, Northern State, Sudan, is notably high 21.3%. Older adults (aged 60 years and above) were significantly more affected ($p < 0.001$). A higher prevalence was also observed in females 23.7% compared to males 7.1%, though this difference did not reach statistical significance ($p = 0.1834$). No significant association was found between hypertension and economic status ($p = 0.255$). Interventions should prioritize age-related risks and consider gender-specific approaches while improving healthcare access and health education among displaced populations.

Keywords: Hypertension, Internally Displaced Persons, Sudan, Conflict, Public Health

مستخلص:

يمثل ارتفاع ضغط الدم مشكلة متزايدة للصحة العامة، لا سيما بين الفئات السكانية الضعيفة كالنازحين داخلياً. هدفت هذه الدراسة إلى تقييم انتشار ارتفاع ضغط الدم وتحديد عوامل الخطر المرتبطة به بين البالغين النازحين داخلياً المقيمين في مراكز الإيواء بمحلية دنقلا، الولاية الشمالية، شمال السودان.

أُجريت دراسة وصفية مقطعية قائمة على المجتمع في الفترة من 22 ديسمبر 2023 وحتى 11 يناير 2024، باستخدام منهجية المسح من مركز إلى مركز آخر. تم اختيار 323 شخصاً بالغاً من النازحين داخلياً (18 عاماً فما فوق) بطريقة عشوائية بعد الحصول على موافقة مستنيرة. تم جمع البيانات من خلال المقابلات وجهاً لوجه والقياسات الجسدية، التي شملت قياس ضغط الدم، ونسبة الجلوكوز العشوائية في الدم، والقياسات الأنثروبومترية.

بلغ عدد المشاركين 323 (27.5% ذكور، 72.4% إناث، متوسط العمر 39.2±15.9 سنة)، وكان الانتشار الإجمالي لارتفاع ضغط الدم 21.3%. لوحظ انتشار أعلى لدى الإناث 23.7% مقارنة بالذكور 7.1% أظهرت العينة نسبة مرتفعة من مؤشرات كتلة الجسم غير الطبيعية 90.7%، وتاريخ عائلي للإصابة بارتفاع ضغط الدم 60.9%، والسكري 54.4%. أشار 60.8% من المصابين بارتفاع ضغط الدم إلى زيارات منتظمة للطبيب. كانت أهم العوائق أمام الالتزام بالأدوية هي الصعوبات المالية (10.1%)، وعدم توفر الأدوية (7.2%).

أظهر ارتفاع ضغط الدم ارتباطاً دالاً إحصائياً بالعمر ($p < 0.001$)، حيث كان 57.1% من الأفراد الذين تبلغ أعمارهم 60 عاماً فأكثر مصابين به. كما لوحظ انتشار أعلى لدى الإناث 23.7% مقارنة بالذكور 7.1%، إلا أن هذا الفرق لم يكن ذا دلالة إحصائية ($p = 0.1834$). لم يسجل ارتباط ذو دلالة إحصائية بالحالة الاقتصادية ($p = 0.255$).

يشير معدل الانتشار المرتفع لضغط الدم 21.3% بين النازحين داخلياً في محلية دنقلا إلى الحاجة للتدخل. تأثرت الفئة العمرية لكبار السن (60 عاماً فأكثر) بدرجة دالة إحصائياً. ينبغي أن تركز التدخلات على المخاطر المرتبطة بالعمر، مع الأخذ في الاعتبار النهج القائم على النوع الاجتماعي نظراً للانتشار الأعلى بين الإناث، إلى جانب تحسين الوصول إلى الرعاية الصحية والتثقيف الصحي بين هذه الفئات النازحة.

Introduction:

Hypertension, commonly known as high blood pressure, is defined as an elevated force of blood against the walls of blood vessels, typically measured as 140/90 mmHg or higher (World Health Organization, 2024). Although prevalent, hypertension poses a significant health risk if left untreated (WHO, 2024). Since individuals with high blood pressure frequently exhibit no noticeable symptoms, routine monitoring is essential for its detection (WHO, 2024).

Blood pressure is expressed as two distinct measurements (WHO, 2024). The systolic pressure reflects the force exerted on arterial walls when the heart contracts, while the diastolic pressure represents the force when the heart relaxes between beats (WHO, 2024). A diagnosis of hypertension is established when blood pressure readings, taken on two separate occasions, consistently show a systolic value of 140 mmHg or above and/or a diastolic value of 90 mmHg or above (WHO, 2024).

The global incidence of hypertension is rising, with forecasts suggesting a prevalence increase of approximately 30% by 2025 (Ahmed *et al.,* 2015). This growth is driven by nutritional transition, sedentary behaviors, various modifiable risk factors, and frail healthcare systems. Consequently, populations in low- and middle-income countries (LMICs) are projected to bear a significantly greater burden, with nearly 75% of individuals with hypertension worldwide expected to live in these regions within the next decade (Ahmed *et al.,* 2015). In fact, projections indicate that within the next decade, nearly 75% of individuals with hypertension worldwide will live in these regions (Ahmed *et al.,* 2015). Despite these alarming trends, there remains a notable scarcity of updated evidence on the current prevalence of hypertension and its determinants across developing areas (Ahmed *et al.,* 2015).

Hypertension may remain asymptomatic for years before escalating to a life-threatening complication (El Achhab *et al.,* 2019). Globally, a significant number of individuals suffer from undetected or untreated high blood pressure with notable disparities observed between different nations (El Achhab *et al.,* 2019). According to the JNC 7 report—"Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure"—approximately 30% of hypertensive cases go unrecognized. Among the recognized cases, only 54% receive treatment, and a mere 34% achieve adequate blood pressure control (El Achhab *et al.*, 2019).

In Sudan, the trend is analogous to global patterns, as the prevalence of hypertension continues to rise. In 2016, the WHO reported that approximately 31.9% of the adult population was diagnosed with hypertension (World Health Organization, 2016).

Hypertension is widely acknowledged to be linked to factors such as low socioeconomic status, excessive alcohol consumption, and limited educational attainment (Noor *et al.,* 2016). The growing prevalence of this condition is primarily driven by a combination of factors, including population growth, aging, unhealthy dietary habits, increased body weight, physical inactivity, obesity, sedentary lifestyles, and mounting psychological and social pressures (Noor *et al.,* 2016). Additionally, ethnicity as a potential risk factor has been a focal point of numerous research studies, highlighting the complex interplay of genetic, environmental, and cultural influences in the development of hypertension(Noor *et al.,* 2016).

Worldwide, millions of people are forced to leave their homes due to conflict, violence, human rights violations, persecution, disasters and the impacts of climate change every year (European Commission, 2023). In 2024, the number of forcibly displaced persons reached record levels, underscoring the urgent need for enhanced humanitarian assistance (European Commission, 2023). As of May 2024, the global number of forcibly displaced individuals has reached an unprecedented 120 million including 43.4 million refugees and 68.3 million IDPs, marking the twelfth consecutive annual increase in forced displacement (European Commission, 2023).

In April 2023, the conflict in Sudan precipitated the largest displacement crisis of the year (European Commission, 2023). Approximately 6.1 million Sudanese were forced to relocate internally, while an additional 1.5 million individuals sought refuge outside the country (European Commission, 2023).

Hypertension is widely recognized as a significant risk factor for chronic cardiovascular and cerebrovascular diseases (Muraspahić *et al.,* 2017). This risk is particularly pronounced among IDPs; due to degraded living conditions that exacerbate health challenges (Muraspahić *et al.,* 2017). Additionally, the integration of refugees is hindered by an unstable political climate and a

weakened economy (Muraspahić *et al.*, 2017). Notably, 60% of refugees have opted for permanent integration as their long-term solution (Muraspahić *et al.*, 2017). The primary challenges faced by refugees and displaced persons include inadequate housing and high unemployment rates (Muraspahić *et al.*, 2017). These issues are compounded by several factors: the inability to complete residential repairs or construction without external assistance, ongoing challenges related to legalizing their living accommodations, poor infrastructure, limited access to financial support such as grants and loans (with only approximately 20% of refugees having resolved their housing issues), insufficient dissemination of information on self-employment opportunities, and overall difficulties in participating effectively in the labor market (Muraspahić *et al.*, 2017). Together, these obstacles significantly impede the successful integration of this vulnerable population (Muraspahić *et al.*, 2017).

Since the war broke out in Sudan and there are many IDPs, the purpose of this study was to determine the prevalence and risk factors of hypertension among adults living in IDPs shelters in Dongola locality, Northern state of Sudan.

Methodology:

Study Design:

A descriptive cross-sectional community-based study was conducted as a shelter-to-shelter survey between 22, December 2023 to 11, January 2024 among Adult living in IDPs shelters in Dongola locality, Northern state of Sudan. The capital of Northern State, lies on the west bank of the River Nile, approximately 534 km north of Khartoum.

Study Population:

The population included Sudanese adult IDPs (≥18 years) residing in displacement shelters. Exclusion criteria were age <18 years, residency outside shelters, and pregnancy.

Sample Size:

All participants presenting to the study area and fulfilling the criteria for inclusion, in the period of 22, December 2023 to 11, January 2024 was included. The total number of participants (323) was distributed to the sheltering homes according to size allocation of each shelter. Each participant in the shelters was randomly selected through lottery using a list of IDPs in displacement shelters as a sample frame. The total sample size of 323 participants was calculated using the Raosoft Online Calculator (Raosoft Inc., 2023), based on a population size of 2892 individuals, a 5% margin of error, and a 95% confidence interval.

Data Collection: A structured, pretested questionnaire gathered socio-demographic data, medical history, and risk factors. Trained medical students collected data through interviews and measured blood pressure (using a validated sphygmomanometer, after resting for at least 10 min in the sitting position and the arm was kept at the level of the heart. With an appropriate-size cuff, the mean of two (at an interval of 1–2 min) blood pressure readings were calculated) (Bushara *et al.*, 2015). Random blood glucose Capillary, blood was obtained through a finger prick technique, after sterilization by alcohol (Bushara *et al.*, 2015). Random blood samples were tested for glucose level using a Glucometer (PERFECT 61, SUKKAR, CMC MEDICAL DEVICES & DRUGS, S.L, SPAIN). Diagnosis of diabetes was based on the American Diabetes Association 2022 criteria (Bushara *et al.*, 2015). An individual with a random blood sugar (RBS) ≥ 200 mg/dL (11.1 mmol/L) was considered diabetic (Bushara *et al.*, 2015) (in which diabetes and hypertension. Both conditions often coexist as part of the metabolic syndrome, Moreover, diabetes accelerates vascular damage, increasing the risk of hypertensive

complications such as stroke, heart failure, and chronic kidney disease) (Time Magazine, 2025). participants weight and height were also measured; BMI was calculated according to formulae; body weight (in kilograms) over the height squared (in centimeters).

Data Analysis: Data was analyzed using MS Excel 2016. Descriptive statistics summarized demographic characteristics. Associations between hypertension and variables was assessed using Chi-square tests and logistic regression, with $p<0.05$ considered statistically significant.

Ethical Considerations:

The study was conducted in compliance with the Declaration of Helsinki. Ethical approval was granted by the Research Ethics Committee of the Ministry of Health, Northern State, Sudan under the number 13/2023 on 1/12/2023. Informed consent was obtained from participants after explaining the purpose, method, tools, and duration of the study. Participation was voluntary, and participants could withdraw without penalty.

Results:

Participant Characteristics: Of 323 participants, 89 (27.5%) were male and 234 (72.4%) female (male-to-female ratio 1:2.6). The mean age was 39.2±15.9 years, participants below 50 years old were 73% and 90.7% having abnormal BMI. An education profile of the participants showed that 13.9% are not educated.

Health Conditions:

- Family history of hypertension was reported by 60.9% of participants.
- Diabetes mellitus were reported by 54.4% of participants.
- Cardiovascular diseases were reported by 19% of participants, primarily including ischemic heart disease, heart failure, and cerebrovascular events such as stroke.

  (This classification reflects the most common cardiovascular conditions globally and regionally, as the study collected self-reported data without sub type specification.) (Omar *et al.*, 2020).

- Renal diseases were reported by 13% of participants, While the specific types were not identified in this study, the coexistence of hypertension and renal impairment underscores a critical public health concern. Hypertension contributes to renal damage and progression to chronic kidney disease, while renal dysfunction exacerbates blood pressure elevation (Burnier & Damianak, 2023).

Hypertension Prevalence: Hypertension was present in 69 participants 21.3%, higher in females 23.7% than males 7.1%. Older age (≥60 years) was significantly associated with hypertension (57.1%, $p<0.001$).

Barriers to Care: Of hypertensive participants, 91.3% were prescribed long-term medication, but only 65.2% adhered regularly. Barriers included cost 10.1%, drug shortages 7.2%, and lack of motivation 8.8%. Regular doctor visits were reported by 60.8%, primarily at private clinics 30.4%.

Table 1: Demographic and socioeconomic characteristics of the participants (N: 323)

Variables		Frequency	Percent %
Age	18-29	3	3.7%
	30-39	6	7.3%
	40-49	20	27%
	50-59	17	37.7%
	60 and above	20	57.1%
	Don't know	3	42.8%
Gender	Male	89	27.55%
	Female	234	72.4%
Average Monthly Income	Less than 80 $	53	25.6%
	80 – 100 $	3	11.1%
	101 – 120 $	2	8.3%
	More than 120 $	11	16.9%

Prevalence of Hypertension:

As shown in Table 2 prevalence of hypertension is 21.3%. Females were found to have a higher prevalence than males (23.7%, 7.1% respectively)

Table2: prevalence and duration of hypertension (N: 69)

Duration (Years)/ Frequency			
First time	**< 5 years**	**> 5 years**	**Total**
2 (0.6%)	4 (1.2%)	63 (19.5%)	69 (21.3%)

Interruptions in Medical Care and Access to Medications:

As summarized in Table 3, out of the 69 (21.3%) of Hypertensive participants, 63 (91.3%) were on long-term medications prescribed by their doctor, but only 65.2% of them used their prescribed medications regularly. The data showed that the reasons for interruption in medication use were financial constraints 10.1%, non-availability of their medications in pharmacies 7.2%, lack of motivation to take their medications 8.8%. Furthermore, 60.8% of participants with Hypertension regularly visited a doctor since the displacement. The visits were at the accommodation shelter clinic 1.4%, a governmental public hospital 14.4%, or a private clinic 30.4%. However, 37.6% of participants were unable to visit a doctor at any point during their stay in the displacement shelter. The reported reasons for not visiting their doctor were

financial issues 10.1%, Neglect 20.2%, or busy 4.3%. Table 4 show the Association between Socio-demographic Characteristics of participants with Hypertension.

Table 3: Interruptions in Medical Care and Access to Medications Among participants with Hypertension "N: 69"

Variables					Frequency	Percent%
Doctor Visiting	Yes (Where do you visit him?)	Diagnosis on this visit			1	1.4%
		Health center			21	30.4%
		Nearby primary health care clinic			10	14.4%
		Nearby hospital			10	14.4%
	No (why didn't you visit him?)	I cannot afford the cost			7	10.1%
		I don't like doctors			1	1.4%
		Busy			3	4.3%
		I don't know that I have to go to doctors			1	1.4%
		Neglecting			14	20.2%
		there is a doctor in my family			1	1.4%
Access and regular use of medication	Yes	Yes (doctor prescribed any medication to me)	Yes I take my medication regularly		45	65.2%
			No I did not take them regularly	I cannot afford the cost	7	10.1%
				Medications are not easily available	5	7.2%
				I do not like to take medications	2	2.8%
				I do not like the side effects of the medication	1	1.4%
				I prefer alternative medicine	2	2.8%
				Other	1	1.4%
	No	No (doctor did not prescribed any medication to me)			5	7.2%

Association between Socio-demographic Characteristics of Participants and access to Health Care Services:

- Data analysis revealed a statistically significant association with age, where 57.1% of individuals aged 60 years and above were hypertensive ($p < 0.001$). A higher prevalence was also observed among females 22.6% compared to males 7.1%, but this difference did not reach statistical significance ($p = 0.1834$). While no significant association was found with economic status ($p = 0.255$), financial hardship remains a potential barrier to hypertension management in this population. (Table 4).

Table 4: Association between Socio-demographic and Socio-economic Characteristics of participants with Hypertension "N: 323"

Variables		Frequency	P-value
Age	18-29	80	< 0.001
	30-39	82	
	40-49	74	
	50-59	45	
	60 and above	35	
	Don't know	7	
Gender	Male	89	< 0.1834
	Female	234	
Marital status	Single	45	< 0.0288
	Marriage	238	
	Divorced	17	
	Widowed	23	
Original place of residence	Omdurman	217	< 0.0078
	Khartoum	60	
	Bahri	45	
	Neiala	1	
Average Monthly Income	Less than 80 $	207	< 0.255
	80 – 100 $	27	
	101 – 120 $	24	
	More than 120 $	65	
Length of displacement	Less than 10 weeks	54	< 0.0127
	10-18 weeks	72	
	More than 18 weeks	192	

	Don't know	5	

Discussion:

One of the most significant public health issues is hypertension, which can lead to disability and death for people if it is not well treated and managed. In addition to pharmacological treatment, non-pharmacological management needs careful consideration in order to control hypertension and associated consequences. This study has shed light on the significant prevalence of hypertension among the internally displaced people (IDPs) community living in shelters in Dongola locality, Northern State of Sudan. The findings demonstrate that hypertension affects a substantial portion of this vulnerable population, with notable differences observed across various socio-demographic factors.

One of the primary findings of this study is the higher prevalence of hypertension among females 23.7% compared to males 7.1%, this high prevalence aligns with findings from other conflict-affected regions such as Ukraine (European Commission, 2023). This gender disparity is critical suggesting that females in the IDP community may be facing disproportionate psychological stress, malnutrition, or resource-access barriers, which could override the typical p-value threshold observed in stable populations. It is crucial to investigate these underlying causes further and develop gender-specific interventions to address these disparities.

The age of participants also showed a significant association with hypertension, with older individuals being more affected. This aligns with global trends where age is a well-known risk factor for hypertension (Omar *et al.*, 2020). The high prevalence among the older population underscores the need for targeted health programs that cater to the aging population within the IDPs, focusing on regular screening and management of hypertension.

While the statistical association between hypertension and economic status did not reach significance (p=0.255), financial hardship (10.1% cost, 7.2% drug shortages) remains the primary barrier to care and adherence (Lyles *et al.*, 2020; Patel & Jalal, 2022). The stress of displacement and lack of employment may create a uniform low socioeconomic context in the shelters, masking the differential effect of income on blood pressure that is typically seen in stable communities. The exceptionally high rate of abnormal BMI 90.7% and high family history of comorbidities (Diabetes 54.4%, Cardiovascular disease 19%) among participants suggests that the IDP population is entering displacement with a significant pre-existing burden of Non-Communicable Diseases (NCDs). This underscores the importance of integrated chronic disease management in IDP settings (Bukhman *et al.*, 2021).

The study also revealed that a large proportion of the participants had a family history of hypertension 60.9%, diabetes mellitus 54.4%, and other comorbid conditions such as cardiovascular and renal diseases. This indicates a high burden of non-communicable diseases within the IDPs community, necessitating comprehensive healthcare strategies that address multiple health issues concurrently.

Additionally, the interruptions in medical care and medication adherence due to financial issues, medication unavailability, and lack of motivation are concerning. These barriers to effective hypertension management need to be addressed through community-based programs that provide education, financial support, and improved access to healthcare services.

In conclusion, the findings of this study highlight the critical public health challenge posed by hypertension among IDPs living in shelters in Dongola Locality, Northern State of Sudan. Effective interventions must be multifaceted, addressing gender-specific needs, enhancing economic support, and ensuring regular healthcare access. The insights gained from this study

can inform policymakers and healthcare providers in devising strategies to manage and prevent hypertension, ultimately improving the health and well-being of this vulnerable population.

Our results advocate for gender-sensitive, community-based interventions focusing on education, screening, and continuous care.

Conclusion:

Hypertension prevalence among IDPs living in displacement shelters in Dongola locality, Northern State, Sudan, is notably high 21.3%. Older adults (aged 60 years and above) were significantly more affected ($p < 0.001$). A higher prevalence was also observed in females 23.7% compared to males 7.1%, though this difference did not reach statistical significance ($p = 0.1834$). No significant association was found between hypertension and economic status ($p = 0.255$). Interventions should prioritize age-related risks and consider gender-specific approaches while improving healthcare access and health education among displaced populations.

Limitations:

This cross-sectional study limits causal inference. Self-reported data may underestimate undiagnosed hypertension. Findings may not generalize to IDPs outside shelters.

Recommendations:

Policymakers should prioritize accessible healthcare for IDPs, including free hypertension screening and subsidized medications. Further longitudinal studies are needed to explore causal pathways

Clinical trial number:

Not applicable.

Funding:

None.

Data availability statement:

The data supporting this study are not publicly available due to ethical considerations. However, they can be made available upon reasonable request by contacting Noura Eltayb Abdulkarem Hussain at NouraHussain85@yahoo.com

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Isolation and Identification of *Salmonella* in Milk and Milk Products in Dongola,Sudan January 2025

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Abstract:

The primary objective of this study was to isolate and identify *Salmonella* in milk and milk products in Dongola, Sudan, and to evaluate associated consumer hygiene practices, storage conditions, and awareness. Secondary objectives included the identification of Staphylococcus species and Escherichia coli, assessment of laboratory test efficacy, and determination of risk factors for contamination.

A cross-sectional descriptive study was conducted in January 2025. A total of 60 dairy samples (20 raw milk, 21 Laban/yogurt, and 19 Gibna/cheese) were collected from farms, markets, and retail shops in Dongola. Microbiological analysis included selective plating on MacConkey and XLD agars, followed by biochemical tests (Indole, Urease, TSI, Citrate) for identification of *Salmonella*, *Staphylococcus spp.*, and *E. coli.* Additionally, 60 consumers were surveyed using structured multiple-choice questionnaire to assess dairy handling practices, storage habits, and awareness of *Salmonella*. Data were analyzed using descriptive statistics and inferential tests (Chi-square, Cramer's V).

Salmonella was detected in 6.7% of samples, with higher prevalence in raw milk (10%) compared to Laban (4.8%) and Gibna (5.3%). *Staphylococcus species* were the most frequently isolated pathogen (80%), followed by E. coli (13.3%). No significant difference in contamination rates was observed across dairy types ($p = 0.9417$). Laboratory analysis indicated that Indole and MacConkey tests were highly reliable for pathogen identification, whereas Urease showed weak correlation. Consumer surveys revealed that all participants practiced udder washing and disinfection, but cold-water container cleaning and storage beyond 24 hours were common. Despite 98.3% perceiving Laban as the safest product, laboratory results showed contamination across all products.

Dairy products in Dongola are moderately contaminated with *Salmonella*, with higher prevalence of *Staphylococcus* and *E. coli*, highlighting systemic hygiene deficiencies. Laboratory tests, particularly Indole and MacConkey, are effective for pathogen identification. Consumer awareness alone is insufficient to prevent contamination, emphasizing the need for improved hygiene practices, pasteurization, and regulatory oversight to ensure dairy safety.

Key words: *Salmonella*, Milk, Dairy product, Foodborne pathogens, Public health, *Salmonella* contamination, Raw milk

مستخلص:

الهدف الرئيسي لهذه الدراسة هو عزل وتحديد السالمونيلا في الحليب ومنتجات الألبان في دنقلا السودان، وتقييم ممارسات النظافة وظروف التخزين والوعي لدى المستهلكين. وشملت الأهداف الثانوية تحديد أنواع المكورات العنقودية والإشريكية القولونية ،وتقييم فعالية الاختبارات المعملية ،وتحديد عوامل خطر التلوث أُجريت دراسة وصفية مقطعية في يناير 2025.

جُمع ما مجموعه 60 عينة من منتجات الألبان (20 عينة من الحليب الخام ،و21 عينة من اللبن/الزبادي،و19 عينة من الجبن/الجبن) من المزارع والأسواق ومحلات البيع بالتجزئة في دنقلا. شمل التحليل الميكروبيولوجي زرعًا انتقائيًا على أوساط ماكونكيو XLD،تلاه ا ختبارات كيميائية حيوية (الإندول،واليورياز ،وTSI،والسترات) لتحديد السالمونيلا ،والمكورات العنقودية ،والإشريكية القولونية. بالإضافة إلى ذلك، تم استطلاع آراء 60 مستهلكًا باستخدام استبيانات منظمة متعددة الخيارات لتقييم ممارسات التعامل مع منتجات الألبان، وعادات التخزين، والوعي بالسالمونيلا. تم تحليل البيانات باستخدام الإحصاء الوصفي والاختبارات الاستدلالية (اختبارمربع كاي،ومعامل كرامر .(V):تم الكشف عن السالمونيلا في 6.7% من العينات، مع انتشار أعلى في الحليب الخام (10%) مقارنةً بالزبادي (4.8%) والجبنة (5.3%). كانت أنواع المكورات العنقودية هي العامل الممرض الأكثر عزلًا (80%)، تليها الإشريكية القولونية (13.3%). لم يُلاحظ فرق معنوي في معدلات التلوث بين أنواع منتجات الألبان .(p = 0.9417) أشارت التحاليل المخبرية إلى أن اختبارات الإندولوماكونكي تتمتع بموثوقية عالية في تحديد مسببات الأمراض، بينما أظهر اختبار اليورياز ارتباطًا ضعيفًا. وكشفت استطلاعات رأي المستهلكين أن جميع المشاركين يمارسون غسل وتطهير ضرع الأبقار، إلا أن تنظيف الحاويات بالماء البارد وتخزينها لأكثر من 24 ساعة كان شائعًا. وعلى الرغم من أن 98.3% من المستهلكين اعتبروا اللبن المنتج الأكثر أمانًا، فقد أظهرت نتائج المختبر وجود تلوث في جميع المنتجات :منتجات الألبان في دنقلا ملوثة بشكل متوسط بالسالمونيلا ،مع انتشارأكبر للمكورات العنقودية والإشريكية القولونية ،مما يسلط الضوء على أوجه القصور المنهجية في النظافة. تُعد الاختبارات المعملية، وخاصة الإندولوماكونكي، فعالة في تحديد مسببات الأمراض. ولايكفي وعي المستهلك وحده لمنع التلوث، مما يؤكد الحاجة إلى تحسين ممارسات النظافة، والبسترة، والرقابة التنظيمية لضمان سلامة منتجات الألبان..

Introduction:

Milk and milk products are essential components of human diets worldwide, providing high-quality proteins, essential vitamins, minerals, and bioactive compounds that contribute to growth, immunity, and overall health [1]. In many countries, including Sudan, milk is consumed in raw or minimally processed forms such as raw milk, yogurt (Laban), and traditional cheese (Gibna). These products, if not handled or stored properly, can serve as vehicles for pathogenic bacteria, leading to foodborne diseases [2].

Among these pathogens, *Salmonella spp*. is particularly important because it causes salmonellosis, a significant public health concern worldwide. Salmonellosis can range from mild gastroenteritis to severe systemic infections, especially in immunocompromised individuals, children, and the elderly [3]. Contamination of milk and dairy products with *Salmonella* may occur at multiple stages, including milking, storage, processing, and distribution. Cross-contamination through unclean containers, improper storage, or insufficient pasteurization are major contributors [4].

This study aims to investigate the isolation and identification of *Salmonella* in milk and milk products in Dongola, Northern Sudan, during January 2025, and to assess hygiene practices, storage conditions, and consumer awareness that may influence contamination. The findings will contribute to improving dairy safety, reducing the incidence of foodborne illness, and guiding public health policies in Sudan.

Problem Statement:

Milk and dairy products are widely consumed in Sudan, serving as a key source of nutrition for adults and children alike. In Dongola, Northern Sudan, local dairy products such as raw milk, yogurt (Laban), and traditional cheese (Gibna) are often produced using traditional methods, with minimal processing or pasteurization. While these products provide essential nutrients, they also present a significant risk for bacterial contamination if hygiene and storage practices are inadequate [6,7].

Importance of the study:

The study is important because it provides scientific data on the occurrence of *salmonella* in milk and dairy products, which are widely consumed by population. The findings of this research will contribute to improving food safety and protecting public health by identifying potential sources of contamination

Objectives:

General objectives:

To determine the prevalence, microbiological characteristics, and risk factors associated with *Salmonella* contamination in milk and milk products in Dongola, Sudan, and to assess consumer hygiene practices and perceptions related to dairy safety.

Specific objectives:

1. To isolate and identify *Salmonella* spp., *Staphylococcus* spp., and *Escherichia coli* from raw milk, yogurt (Laban), and traditional cheese (Gibna).
2. To assess the efficacy of laboratory biochemical tests (Indole, MacConkey agar, and Urease tests) in identifying bacterial pathogens in dairy products.
3. To evaluate consumer hygiene practices, including udder cleaning, container washing, and storage methods, and assess their association with bacterial contamination.
4. To compare consumer perception of the "safest dairy product" with actual laboratory findings, identifying gaps in knowledge and practice.

Materials and Methods :

Study Area

The study was conducted in Dongola City, Northern State, Sudan, in January 2025. Dongola is located in the northern region of Sudan along the River Nile and is characterized by a hot arid climate, which favors rapid microbial growth when food hygiene and refrigeration are inadequate. Dairy products such as raw milk, Laban (traditional fermented milk), and Gibna (traditional white cheese) are widely produced and consumed in this area using traditional methods, often without strict microbiological quality control. These conditions make Dongola an appropriate area for investigating bacterial contamination of milk and milk products.

Results :

Samples were collected aseptically and analyzed using standard microbiological methods. Isolation and identification were carried out through pre enrichment ,selective enrichment, culturing on selective media ,and biochemical tests .

A total of 60 dairy samples were analyzed (Table 1). The distribution of product types was as follows: Yogurt (Laban) 21 samples (35%), Raw Milk 20 samples (33.3%), and Local Cheese (Gibna) 19 samples (31.7%).

MacConkey Agar Test: 33 samples (55%) were non-lactose fermenters, while 27 samples (45%) were lactose fermenters.

Urease Test: 39 samples (65%) were negative, and 21 samples (35%) were positive.

Indole Test: 42 samples (70%) were negative, and 18 samples (30%) were positive.

Final Laboratory Identification:

- *Staphylococcus species*: 48 samples (80%)
- *Escherichia coli*: 8 samples (13.3%)
- *Salmonella species*: 4 samples (6.7%)
- Interpretation: *Staphylococcus species* was the most common isolate, indicating high contamination prevalence in local dairy products.
- **Analysis:**
- **1. Descriptive Microbiological Findings:**
- A total of 60 dairy samples were analyzed: 20 Raw Milk, 21 Yogurt (Laban), and 19 Local Cheese (Gibna). Laboratory identification revealed the following:
    - Table (1):Descriptive Microbiological Findings

Pathogen	Number of Samples	Percentage (%)
Staphylococcus spp.	48	80.0
Escherichia coli	8	13.3
Salmonella spp.	4	6.7

Breakdown by Product:

- Raw Milk (20 samples): 16 Staphylococcus, 2 E. coli, 2 Salmonella
- Yogurt (21 samples): 17 Staphylococcus, 3 E. coli, 1 Salmonella
- Local Cheese (19 samples): 15 Staphylococcus, 3 E. coli, 1 Salmonella
- **A. Product Type vs. Pathogen Isolation**
- The efficacy of laboratory biochemical tests in predicting the final pathogen identification:

Table (2): B. Diagnostic Test Efficacy

Q#	Question	Category	Frequency	Percent	Valid %	Cum %
1	Sample Number	1 to 60	(Individual)	1.7%	1.7%	100.0%
2	Type of Product	Yogurt (Laban)	21	35.0%	35.0%	35.0%
		Raw Milk	20	33.3%	33.3%	68.3%
		Local Cheese (Gibna)	19	31.7%	31.7%	100.0%
3	MacConkey Agar Test	Non-Lactose Fermenter	33	55.0%	55.0%	55.0%
		Lactose Fermenter	27	45.0%	45.0%	100.0%
4	Urease Test Result	Negative (-)	39	65.0%	65.0%	65.0%
		Positive (+)	21	35.0%	35.0%	100.0%
5	Indole Test Result	Negative (-)	42	70.0%	70.0%	70.0%
		Positive (+)	18	30.0%	30.0%	100.0%
6	Final Lab ID	Staphylococcus species	48	80.0%	80.0%	80.0%
		Escherichia coli	8	13.3%	13.3%	93.3%
		Salmonella species	4	6.7%	6.7%	100.0%

All 60 participants (100%) were aged 31–50, had University/Higher Education, and were consumers (buyers) in the dairy chain (Table 2).

Q#	Question	Category	Frequency	Percent	Valid %	Cum %
7	Age Group	31–50	60	100.0%	100.0%	100.0%
8	Educational Level	University/Higher Ed	60	100.0%	100.0%	100.0%
9	Role in Dairy Chain	Consumer (Buyer)	60	100.0%	100.0%	100.0%

Analysis:

1. Descriptive Microbiological Findings

A total of 60 dairy samples were analyzed: 20 Raw Milk, 21 Yogurt (Laban), and 19 Local Cheese (Gibna). Laboratory identification revealed the following:

Table (3):Descriptive Microbiological Findings

Pathogen	Number of Samples	Percentage (%)
Staphylococcus spp.	48	80.0
Escherichia coli	8	13.3
Salmonella spp.	4	6.7

Breakdown by Product:

- Raw Milk (20 samples): 16 Staphylococcus, 2 E. coli, 2 Salmonella
- Yogurt (21 samples): 17 Staphylococcus, 3 E. coli, 1 Salmonella
- Local Cheese (19 samples): 15 Staphylococcus, 3 E. coli, 1 Salmonella

2. Inferential Statistical Analysis:

A. Product Type vs. Pathogen Isolation:

- Test: Chi-Square (χ^2)
- p-value: 0.9417
- Cramer's V: 0.0804
- Interpretation: No statistically significant difference in pathogen prevalence between raw milk, yogurt, and cheese. The risk of encountering Salmonella or E. coli is uniform across all products. The very low Cramer's V indicates a negligible association.

Discussion:

The study provided critical insights into the microbiological quality of dairy products in Dongola, Sudan, focusing on the isolation and identification of *Salmonella*, *Escherichia coli*, and *Staphylococcus* species, alongside an evaluation of consumer practices and awareness.

The isolation of *Salmonella* from 6.7% of samples indicated a moderate prevalence, which was consistent with reports from Sudan where prevalence ranged from 2% to 15% depending on product type and region [11,12]. This finding aligned with broader epidemiological trends reported by Majowicz *et al.* [8] and Ao *et al.* [9], who documented that non-typhoidal *Salmonella* (NTS) was a ubiquitous foodborne pathogen causing significant global morbidity. Osman *et al*. [11] highlighted that raw milk and local cheeses, particularly in areas with informal production and distribution, were key vehicles for *Salmonella* transmission, supporting the observation that contamination occurred across multiple dairy types, including Laban and Gibna.

The high prevalence of *Staphylococcus* species (80%) in the study reflected the findings of Foley *et al.* [5], who emphasized that environmental exposure and suboptimal hygiene practices in dairy production contributed to widespread contamination. The detection of *E. coli* in 13.3% of samples further indicated fecal contamination, corroborating global data showing the common co-occurrence of enteric bacteria in dairy products when hygienic standards were not strictly enforced [8,9]. These findings underscored systemic contamination of dairy products in informal markets, which was particularly concerning for public health.

The laboratory analysis revealed that Indole testing had the strongest correlation with final pathogen identification, followed by MacConkey agar, whereas Urease tests were less definitive. This observation was consistent with Doyle and Erickson [15], who emphasized that combining selective media with confirmatory biochemical tests enhanced accuracy in identifying *Salmonella* and related enteric pathogens. Such reliability was critical for diagnostic accuracy, particularly in regions where molecular techniques were limited or cost-prohibitive.

A notable observation in the study was the perception gap among consumers. Despite 98.3% of participants identifying Laban as the safest product, laboratory results demonstrated that Laban, cheese, and raw milk were all susceptible to contamination. Mohamed *et al.* [13] reported similar findings, noting that consumer knowledge did not always translate into safe handling practices, particularly in rural Sudanese contexts. The mismatch between perception and actual contamination highlighted the need for intensive education campaigns focused on practical hygiene interventions.

The study also highlighted storage practices as a critical factor. All dairy products were refrigerated; however, prolonged storage beyond 24 hours contributed to bacterial persistence. This observation supported the conclusions of Havelaar *et al.* [10] and Ahmed *et al.* [14], who argued that refrigeration alone could not eliminate pathogens if initial contamination was present, and that improper post-production handling increased the risk of foodborne illness.

In addition, the study demonstrated that pathogen prevalence was not significantly different across dairy types ($p = 0.9417$), confirming findings from global studies that raw milk, fermented milk, and soft cheeses all represented potential contamination sources [10]. This finding suggested that interventions needed to target the entire dairy supply chain, from production to consumer handling.

Overall, the findings reinforced the complex interplay between microbiological contamination, consumer practices, and public perception, emphasizing the need for integrated approaches to dairy safety, including surveillance, education, and regulatory oversight.

Conclusion:

- **Salmonella Prevalence:***Salmonella* was detected in 6.7% of the samples, indicating a moderate level of contamination in dairy products from Dongola.
- **Other Pathogens:** A high prevalence of *Staphylococcus* species (80%) and *E. coli* (13.3%) was observed, indicating widespread hygiene deficiencies in dairy production and handling.
- **No Product-Specific Risk:** Statistical analysis confirmed that contamination risk did not differ significantly among raw milk, Laban, and Gibna, highlighting that all dairy products were potential sources of infection.
- **Diagnostic Validity:** Biochemical tests, particularly Indole and MacConkey agar, were found to be reliable for pathogen identification, while the Urease test was less effective.
- **Enhance Dairy Hygiene Practices:**
- Train producers on proper cleaning and disinfection of containers with hot water and detergents.
- Encourage consistent udder hygiene and sanitary milking procedures.
- Encourage pasteurization of raw milk and heating of Laban and Gibna prior to consumption to reduce microbial risk.
- Implement regular microbiological testing of dairy products in farms, markets, and shops to monitor Salmonella, E. coli, and Staphylococcus contamination.
- Conduct longitudinal studies to assess seasonal and regional variations in contamination.
- Investigate molecular characterization of Salmonella to identify specific serovars and antimicrobial resistance patterns.

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Genotypic and Phenotypic Variances of Some Wheat (*Triticum aestivum* L.) Genotypes under Northern Sudan Condition

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Abstract:
Twelve genotypes (four cultivated varieties and eight advance pure lines) of wheat (*Triticum aestivum. L.*) were evaluated at Dongola, Sudan, over two seasons (2020/21 – 2021/22) in a randomized complete block design with three replications. Significant differences among the tested genotypes were detected for, days to 50% heading, days to maturity in both season; plant height, 1000- seed weight in the first season and number of seed /spike in the second season for after legume sowing. And for days to 50% heading, days to maturity, 1000- seed weight in both season; biomass/plant, spike length in the first season and number of spikelets/spike, number of seed/spike in the second season.. For after fallow sowing, the highest heritability estimates in the first season was given by days to 50% heading (62.80%) and the lowest (3.99%) by number of spikelets/spike, whereas for after legume sowing the highest was given by days to maturity (93.72%) and the lowest (2.18%) by grain yield/plant for after fallow sowing. The earliest maturing genotypes (69.66, 69.33&70.33days) for Dongola pyt ICARDA heat.Ent 10 and hala pyt - Balady respectively over the two seasons. The highest grain yielding genotype was Gummira (470kg/ha) followed in rank by ICARDA Elet Ent10 (0.342kg/ha) for after legume sowing and highest grain yielding genotype ICARDA heat. Ent 41 (0.261kg/ha) followed in rank by ICARDA heat.Ent10 (0.160 kg/ha) in fallow sowing

Key words: wheat genotypic, phenotypic variances, Dongola

مستخلص:
أجريت التجربة الحقلية لهذه الدراسة خلال الموسمين 2020,21/2021,22 بمزرعة البحوث الزراعية بدنقلا بتصميم القطاعات العشوائية الكاملة بثلاثة مكررات وذلك لتقييم 12 صنف من القمح (5 أصناف مجازة و 7 سلالات).اعلي درجة للتوريث سجلت في الموسم الأول لصفة عدد الأيام اللازمة لظهور السنابل بنسبة 50% (62.8%) بينما كانت الادني لصفة عدد السنيبلات في السنبلة (3.99%) للتجربة المنزرعة بعد المحصول البقولي بينما سجلت صفة عددالايام اللازمة للنضج اعلي درجة للتوريث (13.72%) بينما كانت الأدنى لصفة الإنتاجية / الهكتار (2.18%) للتجربة بالأرض البور.كانت صفة الأكثر تبكيرا للأصناف Dongola pyt(69.66 و71.66) ICADRD heat Ent 10(69.33 و 71.66) لكلا الموسمين علي التوالي للتجربة المنزرعة بعد محصول بقولي و (Dongla pyt 69.66 و72) و (hala pyt 70.33 , ICADRD heat Ent 10 (72.33 (69.33 و73) للموسمين علي التوالي للتجربة المنزرعة بارض بور.
اعلي درجة توريث سجلت لصفات عدد الأيام اللازمة لظهور 50% من السنابل (62.80%) و عدد الأيام الازمة للنضج (45.67%) للتجربة المنزرعة بعد البقول للموسم الأول و الثاني علي التوالي وعدد الأيام اللازمة لظهور السنابل بنسبة 50% (91.90%) وعدد الأيام الازمة للنضج (93.72%) وطول السنبلة (45.81%) في الموسم الأول و عدد الأيام اللازمة لظهور 50% من السنابل (61.63%) وعدد الأيام اللازمة للنضج (51.84%) وعدد السنيبلات في السنبلة (44.83%) وعدد البذور في السنبلة (50.53%) في الموسم الثاني للتجربة المنزرعة بعد البور.قيمة التقدم الوراثي كانت الأعلى في صفة

الإنتاجية / الهكتار (19.82%)للتجربة المنزرعة بعد البقول ولصفة عدد الاوراق في النبات (35.18%) للتجربة المنزرعة بعد البور في الموسم الأول بينما كانت لصفة عدد السنابل في المتر المربع (6.69%) للتجربة بعد البقول ولصفة سمك النبات (12.70%) للتجربة المنزرعة في الأرض البور في الموسم الثاني.

ارتبطت اعلي قيمة لدرجة التوريث مع اعلي قيمة للتقدم الوراثي لصفة عدد الايام اللازمة لظهور السنابل للموسمين ولكلا التجربتين وعدد السنيبلات في السنبلة في الموسم الثاني للتجربة المنزرعة في الأرض البور.

اتبع التقدم الوراثي GA نفس النمط لمعامل الاختلاف الوراثي GCV بينما لم يوجد نمط محدد بين درجة التوريث واي من التقدم الوراثي او معامل الاختلاف الوراثي.

Introduction:

Wheat (*Triticum aestivum* L.) belongs to the family Poaceae (*Gramineae*). It is the most important cereal crop in the world. It is the main grain for human consumption in the temperate regions, which are climatically very suitable for its cultivation. The chromosomes number are (2n = 2x = 42). It's also grown on a large scale in the tropical and sub-tropical regions of the world. It ranks the first in world cereal production since it is the staple food of about one third of the world's population (Igtidar *et. al*, 2010).It is one of major staple food crops grown worldwide (Zhou *et al* 2003; Bhalla *et al*, 2006).

The total world wheat area is estimated to be more than 218,000,000 hectares with average yield of 3.1 t/ha (Salah and Ismail, 2017). The straw used as an animal food. In Sudan, wheat is the second most important cereal crop after Sorghum (Ishag 1994). It was traditionally grown since early times in the Northern state (Lat. 18-22N),The production of wheat in Sudan was began since 2000BC. The total cultivated wheat area was increased to 2800feddan in 1946-1947 season due to improvement in productivity from 300 kg/feddan to 500 kg/feddan (ministry of Agriculture, 1990).The varieties grown were Gizza 155 and Maxicani. However, in spite of the relative success, no wheat was produced in Gezira scheme after the war. This was partly because it became possible to import wheat and partly because sorghum is the main food diet for Gezira tenant's community, which is considered a safeguard for their maintenance and subsistence. Wheat production hasbeen sharply increased from about 220000 MTtons in1970 -71 to over 320,000 MT tons in 2015- 16, due to population growth and rising per capita consumption.

The average annual production of wheat in Sudan during 2006-2009 was about 578,000 tons and the average wheat area harvested was 290,000 hectares, of which some 99.2% was mainly cultivated in irrigated farms in central and northern Sudan. Wheat Yield varied from 1.5 tons ha^{-1} to 2.1 tons ha^{-1} (FAO – 2010).

Wheat production in the Sudan started thousands of years ago on the fertile soils of the banks of the Nile in the Northern Sudan. Attempts to extend the crop to the central irrigated plains south of Khartoum were made in 1918 and 1940 (Ageeb, 1993). In Sudan, wheat is exclusively produced under irrigation during the period from November to March. This period is shorter and has relatively higher temperature than those of traditional wheat producing regions of the world.

Wheat became staple food crop, with total cultivated areas fluctuating in the past 3 decades between 100000 and 350000 ha. However, wheat production in Sudan is generally low and it is not coping with the increasing demand for wheat products (Salah and Ismail, 2017).

The Northern region (Northern State and Nile River State) of the Sudan is characterized by a longer and a cooler winterseason, hence, constitutes the most suitable ecological environment for wheat production. Wheat yields in this region are usually higher than those of the central

parts of the country (Izzeldin, 1996), but due to the high costs of production and limited land in the Northern states (40,000- 75,000 ha), the crop was introduced into the Gezira and New Halfa area (Faki *et al;* 1998). The Northern state is characterized by good fertile soil, suitable climate and availability of irrigation water from River Nile in addition to the ground water resource in the Nubian sand stone. Moreover, the area is free from diseases compared to many parts of the Sudan (very dry weather with hot summer) and farmers are well experienced in wheat production (Northern State Ministry of agriculture, animal wealth and irrigation, 1995).

Due to the strategic importance of wheat as basic food crop ,the plans of state has given great concern to the production of wheat in its future plans for agricultural expansion .wheat cultivated areas increased from 13000 feddan in 1995/1996 season to 129-128 feddans in 2003/2004 season with an increase of 893 between the two periods.The productivity of wheat in Sudan has been increased after release of many high yielding cultivars, which performed better under short and warm winter growing season. To improve wheat grain yield, many studies were conducted to optimize efficient technical packages such as sowing date, seed rate and fertilizers. Generally, improved varieties for both yield and better cultural practices have contributed to yield increment, but it is difficult to quantify the effect of each management and environmental factors affect the improvement of yield and quatily can be achieved when an improved varities and improved agronomic package for production is developed but this needs intensive research work.

The main problem of wheat production in the Northern State of the Sudan, is lack of high yielding- early maturing varieties that suit the worm tropical climate that prevailed throughout the Sudan. Therefore, the objective of this study is to assess the genotypic, phenotypic and environmental variances in twelve varieties of wheat in the Northern State of the Sudan-Dongola.

Materials and Methods:

The experimental work of this study was conducted during winter seasons of2020- 2021and 2021–2022. It aims to evaluate the genotypic and phenotypic performance of late sown, twelve wheat (*Triticum aestivum* L.) genotypes, sown after faba bean legume and fallow. The location of the experiments was Dongola Research Farm, located in Dongola, -Northern State of the Sudan (Latitude 19 ° - 10 ° N and Longitude 29 °- 30 ° E). Its climate is hot dry summer, low temperatures in winter, scarce rainfall, and high wind speed. The diurnal range of temperature is wide all the year round. The mean maximum and minimum temperatures are 36.4 and 18.2 °C, respectively. Temperatures as high as 49 °C are uncommon in the period extending from April to June. In winter, temperatures as low as 1.0°C have been recorded. The climate is hyper- arid with a vapour pressure of only 10.8 mb and a relative humidity of less than 20%. The mean bright sunshine duration is 10.5 hours (at 87% of possible hours). Clouds are generally rare. Solar radiation is as high as 25.88 MJM. Rainfall is scarce with a mean annual amount of 12.3mm. Wind prevails from the north southwards with mean speed of 15.7 km/hr. (Izzedin, 1996).

Materials : Twelve genotypes was used in this study

Table (1): Pedigree and genotypes names.

Genotypes source or Name	Genotypes Symbols	Pedigree
Bohain	g_1	Released cultivar
Nebta	g_2	Released cultivar
Goumria	g_3	Released cultivar
PYT Dongla	g_4	Dongola Research genotype.
Kidir	g_5	Wad Medani Research genotype.
19PYT	g_6	Wad Medani Research genotype.
ICARDA.Elite.Ent10	g_7	NE.JMAH.14/4/BL2064//SW89.5124* 2/FASAN/3/T, LH/5/05W90045.
Imam	g_8	Released cultivar
ICARDA.Heat.Ent10	g_9	HUBARA.5/PASTOR.2/6/88ZHONG218//CTK/VEE/3/KV Z/GV//PR/4/KRAS NOVODO PADSKA YA25/5/K S82117/MLT.
ICARDA.Heat.Ent49	g_{10}	CHAM.6/PERW//MiLAN/PASTOR/3/CHAM .6/PERW/4/ATTiLA//VEE#5/DOBUCS.
ICARDA.Heat.Ent41	g_{11}	ATTiLA/HEiLo//Libya#3.
ICARDA.Heat.Ent9	g_{12}	PRL/2*PASTOR//SER1/4/MILAN/KAUZ//PR1N1A/3/BABAX/5/HUBARA.3*2/SHUHA.4/6/KAMB2/PANDION.

Two experiments were carried out each year and over two consecutive seasons (2020/21 and 2021/22). A randomized complete block design (RCBD) with three replications was used. late in the season, sowing date was 1st February in both seasons. In both seasons sowings was done on flat by drill with seed rate of 60 kg/ha and row spacing of 20cm. Irrigation water was applied at an interval of 8and 5days. Hand weeding was carried once three weeks after tow herbicides,2,4-D and traxsos were used to control broad leaves and grasses respectively after sowing. The crop was dove at maturity .

Ten randomly selected plant were used, to record data other traits respectively in both seasons. Plant height (cm). days to 50% heading, stem girth, number of leaves, days to maturity, spike length (cm), number of spike/m^2, number of seed/spike, number of spikelets per spike, 1000-grain weight (g).

The collected data was subjected to the standard procedure of the analysis of variance described by Gomez and Gomez (1984) for the randomized complete block design each year separately, then the combined analysis of variance was executed following the same procedure. Mean separation was carried by Duncan's multiple range test (DMRT) at 0.05 level of significance was performed, according to Gomez and Gomez (1984).

Genotypic ($\delta^2 g$) and phenotypic variances ($\sigma^2 ph$): were obtained from the analysis of variance Table (2) according to Comstock and Robinson (1952) as follows:

$\sigma^2 g = (MS1 - MS2) / r$

$\sigma^2 ph = \sigma^2 g + \sigma^2 e$

$\sigma^2 e = MS2.$

Where:

r: replication, MS_1: Mean square for genotype, MS_2: Mean Square for error.

Table (2) the form of analysis of variance and expected mean squares for RCBD:

Source of variation	D.F	M.S	E.M.S
Replication	(r-1)	M_3	
Genotype	(v-1)	M_2	$r\sigma^2 g+o^2 e$
Error	(r-1)(v-1)	M_1	$\sigma^2 e$
Total	(rv-1)	$(M_1+M_2+M_3)$	

Where:

r =Number of replication., v = Number of genotypes.

M_1, M_2 and M_3 =Mean squares for error, genotype and replication, respectively.

$\sigma^2 g$ = Genotypic variance and $\sigma^2 e$ = Error variance.

Table (3) the form of combined analysis of variance and mean squares expectations for the pooled data (combined analysis) of the two seasons.

Source of variation	D.F	M.S	E.M.S
Season	(S-1)	M_1	$\sigma^2 e+vq^2 r/S+vrq^2 S$
Replicat x season	S(r-1)	M_2	$\sigma^2 g+vq^2 r/S$
Genotypes	(v-1)	M_3	$\sigma^2 e+ro^2 v/S+rSo^2 v$
Genotypes season	(S-1)(r-1)	M_4	$\sigma^2 e+rq^2 v/S$
Pooled error	S(r-1)(v-1)	M_5	$\sigma^2 e$
Total	S(rv-1)		

Where:

S = Number of season.

M_1, M2, M3, M4and M_5 = Mean squares for season, replication within season, genotypes, genotypes x season and pooled error, respectively.

$\sigma^2 e$ = pooled error variance.

$\sigma^2 r$ = Replicate variance.

$\sigma^2 v$ = genotypes variance.

$\sigma^2 r/S$ = variance of replicate x season interaction.

σ^2/S = variance of genotypes x season interaction.

The mean values were used for genetic analyses to determine phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), according to Singh and Chaudhury (1985) as follow:

Genotypic variance $\sigma^2 g = \frac{M2 - M3}{r}$

Phenotypic variance $\sigma^2 ph = \sigma^2 g + \sigma^2 e$

Results and Discussion:

Phenotypic, Genotypic and environmental variances:

Values of genotypic, phenotypic and environmental variances were represented in tables 3 and 4.

Table (4)phenotypic (δ^2 ph),genotypic (δ^2 g),and environmental (δ^2e) variances for the different characters in 12wheat Genotypes evaluated over two season 2020-2021, 2021-2022 after legume sowing.

	1st season			2nd season		
Characters	δ2g	δ2e	δ2ph	δ2g	δ2e	δ2ph
1-Days to 50% heading	25.3	7.24	32.34	6.416	3.80	10.216
2-Days to maturity	11.393	4.51	15.903	6.64	7.90	14.54
3-plant height (cm)	16.175	26.34	42.513	9.763	29.60	39.363
4-1000seed weight (g)	5.076	2.79	7.86	2.41	8.21	10.62
5-Number of spikes/m2	7.886	64.27	72.156	47.04	163.08	210.12
6-Bioumass (kg/ha)	-	-	-	0.236	0.11	0.346
7-Grain yield (kg/ha)	4.33	0.199	0.203	0.0393	0.208	0.2473
8-Number of leaves/plant	-	-	-	-	-	-
9-stem girth	0.01	0.14	0.15	0.0133	0.31	0.3233
10-Number of spikelets/spike	0.293	0.88	1.173	0.0766	1.84	1.9166
11-spike length (cm)	0.16	0.55	0.71	-	-	-
12-Number of seed/ spike	-	-	-	12.356	18.43	30.786

(-) can not be calculated because the genotypic variance has negative significant.

Table (5) phenotypic (δ^2ph) ,genotypic (δ^2g) and environmental (δ^2e) variances for the different characters in 12 wheat genotypes evaluated over two season 2020-2021 , 2021-2022 after fallow sowing.

(-) cannot be calculated because the genotypic variance has negative significant.

Characters	1st season			2st season		
	δ2g	δ2e	δ2ph	δ2g	δ2e	δ2ph
1-Days to 50% heading	18.956	1.67	20.626	5.14	3.20	8.34
2-Days to maturity	9.38	5.34	14.72	4.956	4.61	9.56
3-plant height (cm)	12.73	38.54	51.273	5.6	28.86	34.46
4-1000seed weight (g)	3.66	3.82	7.486	3.48	8.01	11.49
5-Number of spikes/m2	29.283	158.55	187.83	27.806	150.02	177.826
6-Biomass (kg/ha)	-	-	-	-	-	-
7-Grain yield (kg/ha)	0.0116	0.519	0.5306	-	-	-
8-Number of leaves/plant	6.66	0.15	0.156	-	-	-
9-stem girth	0.01	0.13	0.14	3.33	0.29	0.293
10-Numberof spikelets/spike	0.153	1.14	1.293	0.65	0.80	1.45
11-spike length (cm)	0.186	0.22	0.406	-	-	-
12-Number of seed/ spike	8.616	37.63	46.246	17.353	16.99	34.343

Estimates of phenotypic, genotypic and environmental variances in both seasons are represented in tables 4 and 5. The data generally showed greater variations in genotypic and phenotypic variances for most of the characters over the two seasons for both in fallow and after legume sowing. Estimates of Phenotypic and genotypic variances in the first season were not calculated in after fallow sowing for biomass kg/ha and in after legume sowing for biomass kg/ha, number of leaves per plant, and number of seeds per spike. However, in the second season they were not calculated in fallow sowing for biomass kg/ha, spike length, grain yield kg /ha and number of leaves per plant and in after legume for number of leaves per plant and spike length. This is because the environmental variances for these characters were greater than their corresponding phenotypic ones, indicating that the genetic variance was negative, therefore, for these traits estimate of the genotypic variance was difficult to be calculated. Similar negative estimate of genotypic variance was reached by Chekole *et al.* (2016), ferede *etal*, (2020) and Gezahegn *et al.* (2015) in wheat, Ibrahim 1999 in lablab bean and Ibrahim 2009 in guar. Characters, which exhibited more or less similar estimates of genotypic and phenotypic variances in both seasons, included 1000- seed weight and number of spikes /m^2 for after fallow sowing reflecting small genotype x environment variance in these characters. On the other hand, the other characters followed more or less a general trend where they had greater values of phenotypic and genotypic variances in the first season than in the second season for after legume and fallow sowing. The exceptions of this trend were number of spikelets per spike in after legume and number of seeds per spike in fallow sowing which showed greater phenotypic variance in the second season than the first season…..

However, values of environmental variances fluctuated comparably over the two seasons compared to phenotypic genotypic variances following different trend to that of the phenotypic and genotypic variances for most of the characters. Similar results were obtained by Upasna *et al*. (2019), Mekuria *et al*. (2018), Tesfaye *et al.* (2016), Kifle *et al.* (2016), and Arega *et al*. (2010). Environmental variances were higher in the first season than the second season for plant height, days maturity, number of spikes/m, number of spike-lets per spike and number of seed

per spike in after fallow sowing and for days to 50% heading in after legume sowing. Similar results were obtained by Johnson *et al.,* (1955), Eberhart and Russell (1966). On the other hand, environmental variances were greater in the second season than in the first season for, days to 50% heading, 1000-seed weight, and stem girth in after fallow sowing and for days to maturity, plant height, 1000-seed weight, number of spikes/m, grain yield kg/ha, stem girth, number of spike lets per spike and number of seeds per spike. Similar findings were reached by Chekole *et al.* (2016), Gezahegn *et al*. (2015), I-sack (2015), ferede *et al*, (2020), Moslem *et al*. (2014), and Bello *et al*. (2012). Great fluctuation in environmental variances was recorded for plant height (38.54 and 28.86) and number of seeds per spike (37.63 and 16.99) in after fallow sowing. However, for after legume sowing, great fluctuation in environmental variances was recorded for days to 50% heading (7.24 and 3.80), 1000–seed weight (2.79 and 8.21) and number of spikes / m(64.27 and 163.08).

Recommendations:

1. Selection well be affective for days to 50% heading and spikelets/ spike.
2. After legume sowing exhibited more genetic variability.
3. More genotypes are needed to broadening the genetic pool.

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