Alqalam Journal of Medical and Applied Sciences. 2026;9(4):897-904
https://doi.org/10.54361/ajmas.269417

Original article

Prevalence and Types of Anemia among Patients with Colorectal Cancer at Tripoli University Hospital, Libya

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Abstract
Anemia is a common and clinically significant complication among patients with colorectal cancer (CRC), often resulting from chronic gastrointestinal blood loss, tumor-associated inflammation, or iron metabolism disturbances. Despite its prognostic and diagnostic relevance, data on anemia prevalence and types among Libyan CRC patients are scarce. This study aimed to evaluate the prevalence and morphological types of anemia among Libyan colorectal cancer patients before and after chemotherapy and to examine their association with disease stage, tumor site, demographic factors, history of rectal bleeding, and changes in hemoglobin levels following treatment. A retrospective cross-sectional study was conducted at the Oncology Department of Tripoli University Hospital, including 156 patients diagnosed with CRC during 2023–2024. Demographic, clinical, and hematological data were collected from medical records. Anemia was defined according to WHO criteria (Hb <13 g/dL for males, <12 g/dL for females). RBC indices (MCV and MCHC) were used to classify anemia. Associations with clinical and demographic variables were assessed using Chi-square and t-tests; $p < 0.05$ was considered significant. The mean age at diagnosis was 60.6 ± 11.9 years, with 56.4% males. The most common tumor sites were rectum (21.8%), rectosigmoid (19.2%), and sigmoid colon (16.7%). Stage IV was the most frequent at diagnosis (41.0%). Pre-chemotherapy, mean hemoglobin was 11.70 ± 1.72 g/dL, with anemia prevalence of 70.5%, slightly higher in males (75.0%) than females (64.7%, $p = 0.162$). Anemia prevalence did not differ significantly by age group, tumor site, or cancer stage. Patients with a history of rectal bleeding had significantly higher anemia prevalence (80.0% vs. 54.2%; $p = 0.002$). Normocytic normochromic anemia predominated (≈63%), followed by microcytic hypochromic (≈33%) and macrocytic (<1%). Post-chemotherapy (n = 122), mean hemoglobin was 11.89 ± 1.64 g/dL, and anemia persisted in 59.0% of patients, mostly normocytic normochromic (77.8%), with minor increases in microcytic (16.7%) and macrocytic (5.6%) patterns. Anemia is highly prevalent among Libyan CRC patients, predominantly normocytic normochromic, and is significantly associated with a history of rectal bleeding. Despite chemotherapy, a substantial proportion remain anemic, underscoring the importance of early detection, continuous monitoring, and targeted management of anemia in this population.
Keywords. Colorectal Cancer, Anemia, Hemoglobin, Chemotherapy, Disease Stage, Libya

Introduction

Colorectal cancer (CRC) is one of the most common malignancies worldwide and constitutes a major public health challenge because of its high morbidity and mortality [1]. According to global cancer statistics, CRC ranks as the third most frequently diagnosed cancer and the second leading cause of cancer-related deaths globally [2]. It arises from the epithelial lining of the colon or rectum through a multistep carcinogenic process involving genetic alterations and cumulative environmental exposures.

Clinically, colorectal cancer presents with a range of symptoms that often develop insidiously. Common manifestations include rectal bleeding, changes in bowel habits, unexplained weight loss, abdominal discomfort, and anemia [3]. Among these features, anemia is particularly important because it may be subtle, overlooked, or misattributed to other causes, especially in the absence of overt gastrointestinal bleeding [4]. The development of colorectal cancer is strongly influenced by lifestyle and environmental factors. Diets high in red and processed meat, obesity, physical inactivity, smoking, and metabolic disorders have been consistently associated with increased CRC risk [5]. These factors have contributed to a rising incidence of CRC in low- and middle-income countries, including those in the Middle East and North Africa (MENA), where rapid epidemiological transition and Westernization of lifestyle are increasingly observed [6].

Anemia is a common systemic manifestation in patients with colorectal cancer and is typically multifactorial in origin. It may result from chronic gastrointestinal blood loss, tumor-induced inflammation, impaired iron absorption, and inflammation-mediated disturbances in iron metabolism leading to functional iron deficiency [7. The World Health Organization defines anemia as a hemoglobin concentration below 13 g/dL in men and 12 g/dL in women, a condition affecting approximately 25% of the global population, with higher prevalence in developing regions [8,9]. In CRC patients, anemia may represent the earliest clinical indicator of malignancy, particularly in right-sided tumors, where bleeding is often occult, and symptoms remain nonspecific until advanced stages [10].

International evidence has consistently demonstrated a high prevalence of anemia among patients with colorectal cancer at the time of diagnosis. Large European studies have reported anemia prevalence rates ranging from 40% to 60%, with higher frequencies observed in advanced disease stages and right-sided

Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*

tumors [11, 12]. A population-based study from the United Kingdom showed that nearly half of CRC patients presented with anemia, predominantly due to iron deficiency [13]. Similarly, studies from North America have reported anemia prevalence rates between 45% and 55%, emphasizing its strong association with tumor stage, chronic occult blood loss, and systemic inflammation [14].

In low- and middle-income countries, the burden of anemia among CRC patients appears to be even greater. Studies from South and Southeast Asia have reported anemia prevalence exceeding 65%, largely attributed to delayed diagnosis, baseline nutritional deficiencies, and limited access to early screening programs. These findings highlight significant global disparities in the hematological presentation of colorectal cancer [15].

Regionally, evidence from the MENA region consistently indicates a substantial burden of anemia among CRC patients. Hospital-based studies from Egypt have documented anemia in 60–75% of patients at presentation, with microcytic hypochromic anemia being the predominant morphological pattern, particularly in those with rectal bleeding and advanced-stage disease [16]. Similar findings have been reported from Tunisia and Morocco, where anemia prevalence ranged from 55% to 70% and showed significant associations with tumor stage and distal tumor location [17,18]. These regional observations underscore the impact of delayed diagnosis and nutritional factors on anemia severity in North African populations [16].

In Libya, available studies on colorectal cancer have primarily focused on epidemiology, tumor localization, stage at diagnosis, and histopathological characteristics [19-21]. These studies consistently report late-stage presentation and a high proportion of rectal and sigmoid tumors. However, data specifically addressing anemia among Libyan CRC patients remain extremely limited. Although anemia and rectal bleeding are frequently encountered in clinical practice, few local studies have systematically evaluated anemia prevalence, severity, or morphological patterns, and none have comprehensively examined its relationship with tumor stage or treatment status. Given the high baseline prevalence of anemia in the Libyan population, this lack of hematological characterization represents a significant gap in local evidence. Therefore, the present study aimed to evaluate the prevalence and morphological types of anemia among Libyan colorectal cancer patients before and after chemotherapy and to examine their association with disease stage, tumor site, demographic factors, history of rectal bleeding, and changes in hemoglobin levels following treatment.

Methods

Study Design

This retrospective cross-sectional study was conducted at the Oncology Department of Tripoli University Hospital. Medical records of 156 patients diagnosed and managed for colorectal cancer between 2023 and 2024 were reviewed. Only patients with a confirmed CRC diagnosis and complete hematological data were included in the analysis.

Data Collection

Data were extracted retrospectively from archived patient records over a period of approximately one month using a structured data collection form. Collected variables included demographic characteristics (age, sex), clinical features (tumor site, cancer stage at diagnosis, history of chronic diseases, and history of bleeding per rectum), and hematological parameters obtained from complete blood count (CBC) results. Hematological parameters analyzed included hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC), collected both before and after chemotherapy when available. Anemia was defined according to World Health Organization (WHO) criteria [8] as hemoglobin <13 g/dL for males and <12 g/dL for females. Anemia was classified based on RBC indices (MCV and MCHC) as follows:

- Microcytic hypochromic anemia: low MCV and MCHC.
- Normocytic normochromic anemia: normal MCV and MCHC.
- Macrocytic anemia: high MCV.

Statistical Analysis

Data were analyzed using SPSS Statistics software (version 26; IBM Corp., Armonk, NY, USA). Descriptive statistics were applied to summarize demographic and clinical variables. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were reported as frequencies and percentages. Associations between anemia and categorical variables (sex, age group, tumor site, cancer stage, and history of bleeding per rectum) were analyzed using the Chi-square (x^2) test. Comparisons of continuous variables (e.g., hemoglobin levels) between groups were conducted using independent samples t-tests. A p-value < 0.05 was considered statistically significant. Results were presented in tables and figures to illustrate the distribution of anemia according to sex, age, tumor site, cancer stage, and chemotherapy status.

Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*

Ethical Considerations

This study was based on a retrospective review of archived medical records. No direct patient contact occurred, and no identifying information was collected. Patient confidentiality and data privacy were maintained throughout the study.

Results

Patient Characteristics

A total of 156 patients with colorectal cancer were included in the final analysis. The mean age at diagnosis was 60.6 ± 11.9 years, and more than half of the patients (56.4%) were males. Almost one-third of the patients were aged 60–69 years, while only 5.1% were younger than 40 years. Rectum was the most commonly affected anatomical site (21.8%), followed by rectosigmoid (19.2%) and sigmoid colon (16.7%). Most patients were diagnosed at advanced stages, with stage IV representing 41.0% of cases, whereas only 1.9% were detected at stage I. A previous history of bleeding per rectum was reported in 35.3% of patients, while 37.8% had no such history, and 26.9% had an unknown status. Chronic medical conditions were present in 41% of patients, with diabetes mellitus being the most frequent comorbidity, followed by hypertension, and a considerable proportion had a combination of both conditions (Table 1).

Table 1. Table 1. Demographic and clinical characteristics of patients

Variable	Category	n (%) / Mean ± SD
Age (years)		60.6 ± 11.9
Age group	<40	5.1%
	40–49	10.9%
	50–59	28.8%
	60–69	32.1%
	70–79	16.7%
	≥80	6.4%
Sex	Male	56.4%
	Female	43.6%
Anatomical site	Rectum	21.8%
	Rectosigmoid	19.2%
	Sigmoid	16.7%
	Others	42.3%
Stage at diagnosis	Stage I	1.9%
	Stage II	23.7%
	Stage III	33.3%
	Stage IV	41.0%
Bleeding per rectum	Yes	35.3%
	No	37.8%
	Unknown	26.9%
Chronic disease (any)	Yes	41.0%
	No	59.0%
Type of chronic disease	Diabetes mellitus	32.8%
	Hypertension	17.2%
	DM + HTN	23.4%
	Other chronic diseases	26.6 %

Hemoglobin Level and Prevalence of Anemia Pre-Chemotherapy

The mean hemoglobin level before chemotherapy was 11.70 ± 1.72 g/dL (range: 6.50–16.58 g/dL). When analyzed by sex, male patients had a slightly higher mean hemoglobin (11.86 ± 1.84 g/dL) compared with female patients (11.50 ± 1.53 g/dL); however, this difference was not statistically significant (p = 0.24). Prevalence of anemia before chemotherapy was 70.5% overall, indicating a relatively high frequency of anemia in this patient population. Anemia was more common among males (75.0%) than females (64.7%), but the difference was also not statistically significant (p = 0.162) (Table 2).

Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*

https://doi.org/10.54361/ajmas.269417

Table 2. Hemoglobin Level and Pre-Chemotherapy Anemia

Variable	Category	n / Mean ± SD or %	P value
Mean Hemoglobin	Male	11.86 ± 1.84 g/dL	
	Female	11.50 ± 1.53 g/dL	
	Total	11.70 ± 1.72 g/dL	0.24
Anemia	Male	75.0%	
	Female	64.7%	
Anemia	Total / Present	70.5%	0.162
	Total / Absent	29.5%	—

Anemia According to Age, Tumor Site, and Stage

The mean age did not differ significantly between patients with and without anemia (61.17 ±12.1 vs 59.24 ±11.7 years, P = 0.354) (Table 3).

Table 3. Distribution of Anemia before chemotherapy according to age

Anemia pre-chemotherapy		Present	Absent	P value
Age	Count	110	46	P = 0.354
	Mean± SD	61.17 ±12.1	59.24 ±11.7	

When stratified by age group, anemia was present across all age categories, and its prevalence tended to be slightly higher among older patients, although without a statistically significant difference (P = 0.806). Anemia was also similarly distributed according to anatomical tumor site, with comparable proportions between proximal and distal colon involvement (P = 0.923). Patients diagnosed at stage II showed the highest frequency of anemia (75.7%), followed by stage IV (70.3%) and stage III (69.2%), while stage I cases had the lowest proportion (33.3%); however, this variation did not reach statistical significance (P = 0.473) (Table 4).

Table 4. Anemia According to Age, Tumor Site, and Stage

Anemia pre- chemotherapy					
Age group		**Present**	**Absent**	**Total**	**P value**
<40	Count	6	2	8	P = 0.806
	%	75.0%	25.0%	100%	
40–49	Count	10	7	17	
	%	58.8%	41.2%	100%	
50–59	Count	32	13	45	
	%	71.1%	28.9%	100%	
60–69	Count	34	16	50	
	%	68.0%	32.0%	100%	
70–79	Count	20	6	26	
	%	76.9%	23.1%	100%	
≥80	Count	8	2	10	
	%	80.0%	20.0%	100%	
Site involved		Present	Absent	Total	P value
Proximal colon	Count	35	15	50	P = 0.923
	%	70%	30%	100%	
Distal colon	Count	75	31	106	
	%	71%	29%	100%	
Stage at diagnosis		Present	Absent	Total	P value
Stage I	Count	1	2	3	P = 0.473
	%	33.3%	66.7%	100.0%	
Stage II	Count	28	9	37	
	%	75.7%	24.3%	100.0%	
Stage III	Count	36	16	52	
	%	69.2%	30.8%	100.0%	
Stage IV	Count	45	19	64	
	%	70.3%	29.7%	100.0%	

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https://doi.org/10.54361/ajmas.269417

Anemia and Bleeding per Rectum

Anemia was more frequent among patients with bleeding per rectum (80.0%) compared with those without bleeding (54.2%) (P = 0.002). Patients with unknown bleeding status had a prevalence of anemia of 81.0% (Table 5).

Table 5: Anemia and Bleeding per Rectum

Anemia pre- chemotherapy					
Bleeding per rectum		**Present**	**Absent**	**Total**	**P value**
Yes	Count	44	11	55	P = 0.002
	%	80.0%	20.0%	100%	
No	Count	32	27	59	
	%	54.2%	45.8%	100%	
Unknown	Count	34	8	42	
	%	81.0%	19.0%	100%	
Total	Count	110	46	156	
	%	70.5%	29.5%	100%	

Types of anemia before chemotherapy

Analysis of data revealed that slightly less than 2/3 of patients with anemia have normocytic normochromic anemia, and less than one third of them have microcytic hypochromic anemia, and only less than 1% has macrocytic anemia, as seen in Figure 1.

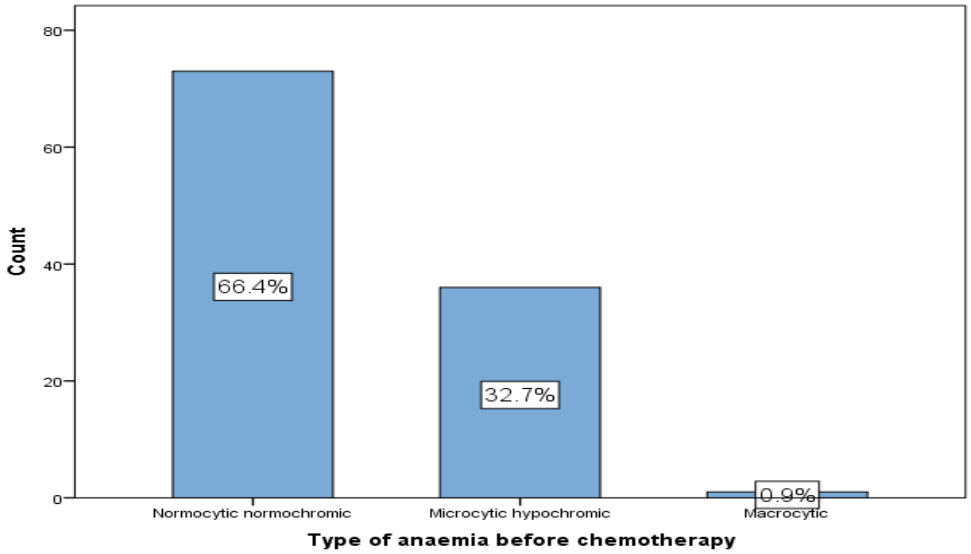

Figure 1. Type of anemia before chemotherapy

Hemoglobin Levels and Prevalence of Anemia Post-Chemotherapy

Complete blood count results after chemotherapy were available for 122 patients, although some data were missing for certain variables, resulting in slightly reduced numbers for sex-specific analyses. The mean hemoglobin level following treatment was 11.89 ± 1.64 g/dL (range: 8.1–15.9 g/dL). Male patients (n = 68) had slightly higher mean hemoglobin (12.04 ± 1.77 g/dL) compared with female patients (n = 54; 11.70 ± 1.45 g/dL); however, this difference was not statistically significant (p = 0.245). Anemia remained relatively frequent after chemotherapy, affecting 59.0% of patients (n = 72), while 41.0% (n = 50) had normal hemoglobin levels. Due to the lack of detailed sex-specific data for anemia after treatment, p-value for comparison between males and females could not be calculated. Despite the reduction in the proportion of anemic patients compared with baseline, anemia continued to be common in this study (Table 6).

Table 6. Hemoglobin Levels and Prevalence of Anemia Post-Chemotherapy (Adjusted for Available Data)

Variable	**Category**	**n / Mean ± SD or %**	**P value**
Mean Hemoglobin	Male	12.04 ± 1.77 g/dL (n=68)	
	Female	11.70 ± 1.45 g/dL (n=54)	
	Total	11.89 ± 1.64 g/dL (n=122)	0.245

Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*

Anemia	Present	72 (59.0%)	— (sex-specific p-value not available)
	Absent	50 (41.0%)	—
	Total	122 (100%)	—

Types of Anemia after Chemotherapy

About morphological patterns, the majority of post-treatment cases (77.8%) displayed normocytic normochromic anemia, whereas 16.7% had microcytic hypochromic changes. Macrocytic anemia represented only 5.6% of post-chemotherapy findings. This pattern remained broadly consistent with anemia observed before initiation of treatment, although a slight increase in macrocytic morphology was noted (Figure 2).

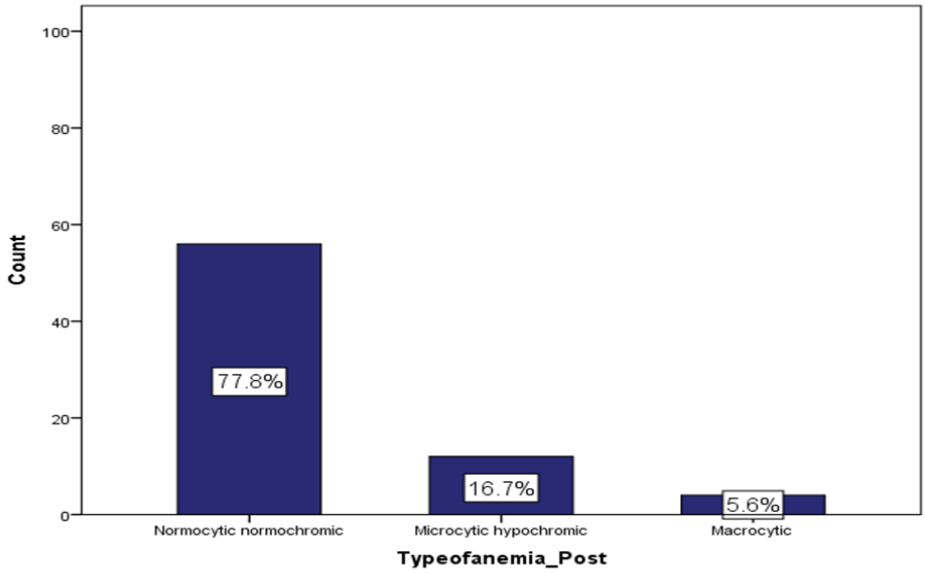

Figure 2. Type of anemia post-chemotherapy

Discussion

This study analyzed 156 CRC patients treated at Tripoli University Hospital between 2023 and 2024, providing a comprehensive assessment of demographics, tumor site and stage, hemoglobin levels, prevalence and morphological types of anemia before and after chemotherapy, as well as their associations with rectal bleeding and chronic comorbidities. The findings demonstrate a high prevalence of anemia, with 70.5% affected before chemotherapy. Although prevalence decreased to 59.0% post-treatment, anemia remained common, indicating a significant clinical problem. High baseline anemia prevalence may reflect tumor-related chronic blood loss, systemic inflammation, nutritional deficiencies, and predominance of advanced-stage disease [22]. In addition, anemia was more frequent in males compared to females; however, this difference did not reach statistical significance (p = 0.162), possibly due to the relatively limited sample size and variability within the study groups. These results are consistent with Libyan studies reporting late-stage presentation and high anemia burden [19-21], as well as regional findings from Egypt, Tunisia, and Morocco[16-18]. Internationally, similar observations have been reported in Europe and Norway, including Wilson *et al.* [11] and Edna *et al.* [12*]*. Lower prevalence rates in some UK cohorts, such as Beale *et al.* [13], may reflect earlier-stage diagnosis, different population characteristics, and varying definitions of anemia. Regarding anemia morphology, normocytic normochromic anemia was predominant both before and after chemotherapy, accounting for nearly two-thirds of cases pre-treatment and increasing slightly post-treatment.

Microcytic hypochromic anemia was less common and decreased after chemotherapy, while macrocytic anemia remained rare. This pattern suggests anemia of chronic disease and inflammation plays a major role, with iron deficiency contributing to a lesser extent [23]. These findings align with studies by Aksan *et al.* [24] and Schneider *et al.* [25*]*, whereas studies focusing on iron deficiency, such as Ploug *et al.* [26, reported microcytic anemia predominance. Analysis of anemia and tumor stage revealed prevalence across all stages, highest in stage II and IV, but without statistical significance (P = 0.473), indicating multifactorial origins. Similar patterns were reported by Väyrynen *et al.* [27] and Gvirtzman *et al.* [28], whereas some multicenter European studies, including Wilson *et al.* [12], found a stronger association with advanced stage. Differences likely reflect sample size, stage distribution, and study design. Regarding chemotherapy, anemia prevalence modestly decreased post-treatment, but over half remained anemic, suggesting chemotherapy alone does not fully correct anemia and may exacerbate it through bone marrow suppression, inflammation,

Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*

and altered iron metabolism. These results are consistent with Muñoz *et al.* [29] and Lindgren *et al.* [30]. while Calleja *et al.* reported improved recovery of hemoglobin levels in CRC patients treated with routine intravenous iron supplementation compared with those who did not receive IV iron [31]. Overall, the study highlights the high burden of anemia among Libyan CRC patients, predominance of normocytic normochromic anemia, and complex interplay between anemia, tumor characteristics, and treatment. Early detection and management of anemia are crucial for improving outcomes, treatment tolerance, and quality of life. The study fills a local knowledge gap and supports future research on iron deficiency assessment and tailored perioperative strategies.

Conclusion

Anemia is highly prevalent among Libyan patients with colorectal cancer, affecting more than two-thirds of patients at diagnosis and remaining common even after chemotherapy. Normocytic normochromic anemia was the predominant morphological pattern, suggesting a major contribution of chronic disease and inflammation rather than isolated iron deficiency. The persistence of anemia across disease stages and after treatment highlights its multifactorial nature and underscores its clinical significance. These findings fill an important local knowledge gap and emphasize the need for systematic evaluation and management of anemia in colorectal cancer care in Libya.

Funding. None**.**

Conflicts of Interest. None

Declarations

AI declaration during the preparation of this work, the authors used AI to improve the grammar and structure without any use in methodology or results. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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Received*: 11-02-2026 -* ***Accepted****: 08-04-2026 -* ***Published****: 15-04-2026*