High fibre dough meal from flour blends of finger millet (Eleusine coracana), Wild melon (*Cucumeropsis mannii*) and Eggplant (*Solanum macrocarpon*): chemical composition, Antioxidant properties and glycemic index

ABSTRACT

*Regular intake of a high-fiber diet promotes a decrease in some chronic cardiac diseases, boosts glycemic regulation, and improves gastrointestinal function. The research assesses the nutrient and antioxidant qualities, as well as glycemic index, of dough meal composed of flour blends from finger millet (FM), wild melon (WM), and eggplant (EP). Flour blends were formulated utilizing optimal mixture design of response surface methodology (RSM), which includes: 100% FM (Control); FM 80: WM 10: EP 10 (FWE3), FM 10: WM 80: EP 10 (FWE5), and FM 45: WM 45: EP 10 (FWE7). The proximate value ranged (Moisture 18.69-20.74, Ash 0.25-1.07, crude Fibre 3.67-4.74, Fat 3.86-8.35, Protein 16.46-22.05, Carbohydrate 45.02-54.71% and energy value 320.59-343.43Kcal). The Minerals ranged (sodium 12.70-18.10, Potassium 13.30-31.50, Calcium 96.80-123.60, Magnesium 406.30-684.60, phosphorus 36.40-47.80, Iron 16.47-27.77, manganese 11.40-19.50, Zinc 2.02-6.98 and Copper 2.02-2.10 mg/100g), but more pronounced in FWE7 than others with Ca:P and Na:K ratios of ≤ 1.The phytate (16.12-28.13), tannin (32.17-47.79), oxalate (6.23-10.33), saponin (1.22-2.30), alkaloid (31.21-40.24) and trypsin inhibitor 1.11-4.44* (mg/100g)*, Phytate:Calcium (0.13-0.23), Phytate:zinc (4.01-9.98) and Phytate:Iron 0.28-1.10 were analyzed, higher value were observed in FWE7 except tannin and saponin. Scavenging ability on ferric reducing antioxidant power (FRAP) 50.77-98.23(mg GAE/g), phenol 6.44-8.44(mg GAE/g), 1,1-diphenyl-2-picryl-hydrazy (DPPH) 54.64-73.07 %, Iron chelation (Fe2+) 68.97-84.85 (mg/mL) and Nitrite oxide (No) 63.07-91.17% were analyzed but, higher in FWE7 than others. The insoluble 25.35-45.03% and soluble 10.65-15.44% dietary fibre were analysed, FWE7 exhibiting low glycemic index and medium glycemic load. The study concluded that FWE7 had the highest radical scavenging capabilities, dietary fiber content, and inhibitory effects against α-amylase and α-glycosidase. This suggests that the high-fiber dough meal, particularly FWE7, may be beneficial in dietary treatments to mitigate oxidative stress and regulate insulin to decrease glucose absorption in the body.*

*Keyword: antioxidant properties, chemical composition, dietary fiber, dough meal and glycemic index*

**1.0 INTRODUCTION**

Proper intake of dietary fiber can diminish the likelihood of acquiring conditions such as hypercholesterolemia, cardiovascular disease, colorectal cancer, and diabetes mellitus. Dietary fiber constitutes the consumable portion of plants that remains undigested and unabsorbed in the small intestine, yet is metabolized by bacteria in the large intestine [1]. The health benefits of plant-based diets are ascribed to bioactive constituents like phytochemicals, antioxidants, and dietary fibers [2, 3]. These factors contribute to the rising trend of adopting high-fiber diets [4, 5]. Cereal grains, especially millets, are abundant in fiber, extraordinarily rich in phytochemicals and minerals, and contribute to the maintenance of the body's pH equilibrium. Millets possess numerous acknowledged health advantages attributable to their robust mineral and vitamin composition, alongside a low glycemic index, dietary calorie, and fat content.

Finger millet (Eleusine coracana), commonly referred to as tamba, serves as a fundamental cereal grain in certain low-income regions [6]. It is gluten-free, non-acid-forming [7], easily digestible, and characterized by a low glycemic index [8]. Its low glycemic index renders it an appropriate option for individuals with celiac disease and diabetes [8], as it is rich in carbs, dietary fiber, important amino acids, and vital minerals [8].

Cucumeropsis mannii, commonly referred to as wild melon, is a member of the Cucurbitaceae family [9]. It is a climbing plant that thrives in humid, wet climates, predominantly in the eastern and southern regions of Nigeria, where it is cultivated for its oil and dietary proteins [9]. It is available in both shelled and unshelled varieties in West African markets and is extensively utilized in West African cuisine [10]. In English, it is referred to as white melon, but in Yoruba, it is called ‘egusi-itoo’ [9]. The shelled seeds may be ground or milled both prior to and following roasting, serving as ingredients in soups and as condiments, as well as in other delicacies in Nigeria, including breakfast dishes and snacks, either as whole toasted seeds or as fried cakes made from milled seeds [11].

Eggplant (Solanum melongena L) is a fundamental component of African heritage and cuisine. It is an agricultural product esteemed for its high fiber content, antioxidant properties, and low caloric value, which significantly contribute to combating diabetes and lipid peroxidation [12]. It is consumed nearly every day by both rural and urban households [13]. They have diverse nutritional and pharmacological attributes that render them a beneficial enhancement to diets. The previous research conducted by Yusuff et al. [14] indicates that heightened consumption of eggplant may reduced the risk of overall mortality, obesity, elevated blood glucose levels, and cardiovascular diseases. Numerous researchers have documented individual crops [8, 9, 11]; however, there is a lack of knowledge regarding the combinations of the three elements in the formulation of the product (Dough meal). The research study aims to produce dough meal from optimum blends of finger millet, wild melon, and eggplant flour, and to evaluate its nutrient quality, antioxidant properties, and glycemic index potential.

**2.0 MATERIALS AND METHOD**

**2.1 Sources of Food Materials**

The basic materials, Finger millet (Eleusine coracana), were procured at the Gwagwalada Market in Abuja. Wild Melon (Cucumeropsi mannii) was acquired at the "Ikole" Market in Ekiti State. Eggplant, characterized by its purple hue, or Brinji (Solanum macrocarpon), was procured at the "Erekesan" market in Akure, Ondo State. The blend ratio of the composite flour was created using Response Surface Methodology (RSM), aiming for high in vitro antioxidant activity (>70).
**2.1.1 Processing of Finger Millet Flour Samples**

Finger millet was converted into flour using the method outlined by Ramashia et al. [8] with minor modifications. Fifteen kilograms (15kg) of finger millet grains were purchased, winnowed, rinsed in clean water, soaked for eight hours, drained, and dried before being processed with a hammer mill (Number 3100, Huddinge, Sweden) and sieved to produce finger millet flour. Enclose in a zip-lock polyethylene bag and maintain at a temperature of 4°C before use.

 **2.1.2 Processing of Wild Melon Flour**

Wild melon was converted into flour using the method outlined by Mehra et al. [9]. Ten kilograms (10kg) of wild melon samples were fried at 60°C for 20 minutes, thereafter de-husked, screened, sun-dried, and ground using a hammer mill (Falling Number 3100, Huddinge, Sweden). The wild melon was defatted with N-Hexane for 8 hours, and the resulting flours were dried (using a cabinet and oven at 60°C and allow to cool atambient temperature) before being ground into flour, packaged in sealed polythene zip lock bags, and stored at a temperature of 4°C before to use.

**2.1.3 Processing of Eggplant Flour**

The method of Uthumporn et al. [15] was utilized with minor modifications; fresh eggplants were rinsed with tap water to eliminate all soil and extraneous material. The eggplants, together with their skins, were cut into thin slices. The sliced eggplants were dehydrated using an air dryer (AFOS Limited, Kingston upon Hull, United Kingdom) at 40°C for 72 hours. Dried eggplants were processed using a Stainless Steel Vertical Type High-Speed Grinding and Pulverizing Machine (Model RT-34, WHL Machinery, Selangor, Malaysia) and subsequently sieved using a 500 mesh sieve. The eggplant flour was stored in a zip-lock polypropylene bag at 4°C prior to usage.
**2.2 Assessment of proximate composition and energy value of flour blends and dough meal**

The proximate components (moisture, total ash, crude fiber, and crude protein, fat) of the extruded breakfast were assessed in accordance with the Association of Official Analytical Chemists [16]. Carbohydrate was derived by subtraction, as follows: Carbohydrate content (%) = 100 - (% moisture + % crude protein + % crude fiber + % fat + % ash)………………………….Equ (1)

 The energy value was determined using the Atwater factor method: [(9×crude fat) + (4×crude protein) + (4×carbohydrate)]. …………………………………………………………..Equ (2)

 **2.3 Assessment of Specific Mineral Composition**
The potassium, magnesium, calcium, sodium, phosphorus, manganese, copper, and iron content were analyzed according to AOAC (16) methodology.
**2.4 Quantitative Analysis of Phytochemical Components in Dough Meal**

The alkaloids, saponins, tannins, phytate, oxalate, and the trypsin inhibition approach delineated by Eze and Kanu [1 7]

**2.5 In-vitro antioxidant analysis of the aqueous extracts from the designed flour mix dough meal samples**

The *in-vitro* antioxidant activity of the aqueous extracts from the meal sample was assessed using standardized techniques. The free radical scavenging activity of the food samples was assessed using Ferric-reducing antioxidant activity (FRAP) as per Zhang and Lin [7].The total phenol free radical scavenging capacity was assessed by Adefega et al. [18]. The free radical scavenging activity of 2,2-diphenyl-1-picrylhydrazyl (DPPH) was assessed according to the methodology outlined by Aluko and Monu [19]. The chelating activity of iron Fe2+ in the aqueous extract of the prepared food was assessed using the method established by Xie et al. [20]. The nitric oxide radical scavenging activity of the meal extract was assessed using the method described by Girgih et al. [21].

2**.6 Assessment of the Inhibitory Effects of α-Amylase and α-Glucosidase on Dough Meal**Levels of α-amylase and α-glucosidase were evaluated using the methodologies outlined by Sheikh et al. [22] and Kumar et al. [23].

**2.7 Assessment of Glycemic Index Analysis**

The glycemic index was obtained by method ascribed by [24]. The glycemic load (GL) was determined by multiplying the carbohydrate content of each dough meal sample in a standard serving by its glycemic index (GI) value [25], as illustrated below:

GL = Net carbohydrate (g) x GI ……………………… Equ (3)

 100

Net carbohydrate = Total carbohydrates in the food sample

**2.8 Dietary Fiber Analysis**

Soluble dietary fiber (SDF) and insoluble dietary fiber were analyzed according to the AOAC [16] method.

2.9 Data Analyses

Data from triplicate readings were analyzed, and results were presented as mean ± standard deviation. One-way analysis of variance was employed to evaluate the means. Significant differences between means were identified using Duncan's test, with a significance level set at (p≤0.05).

**3.0 RESULT AND DISCUSSION**

**3.1 Proximate Composition (%) of Flour Blends and Dough Meal (dry basis)**

The moisture level of flour exhibited substantial variation (p<0.05) among samples. The moisture level of flour mixtures varied between 3.40% and 5.26%. FWE5 demonstrated a minimum value of 4.40%, whilst FWE3 revealed a maximum value of 5.26%. The dough meal varied from 16.69% in FWE5 to 20.74% in FM, whereas the moisture content of the flour blends adhered to the acceptable moisture levels for flour as per WHO [26]. The reduced moisture content identified in this investigation suggests that the flour may demonstrate enhanced shelf durability. Fatoumata et al. [27] noted that low moisture level in food is crucial for storage, since it can inhibit the growth of bacteria, fermentation, and caking. The moisture level of dough meal was higher than that of

**Table 1: Proximate Composition (%) of Flour Blends and Dough Meal (dry basis)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | Moisture Content  | Crude Ash  | Crude Fibre  | Crude Fat  | Crude Protein  | Carbohydrate  | Energy value Kcal |
| **FLOUR BLENDS** |
| FM100 | 4.12±0.02b | 3.17±0.02b | 2.70±0.01 | 1.82±0.02 | 14.92±0.04 | 73.11±0.10a | 376.50 |
| FWE3**80:10:10** | 5.26±0.02a | 3.22±0.02a | 7.05±0.01c | 6.99±0.01c | 37.43±0.04ab | 43.05±0.00f | 384.83 |
| FWE5**10:10:80** | 3.40±0.30c | 3.05±0.00d | 8.98±0.00b | 7.30±0.00ab | 40.76±0.00a | 36.51±0.10h | 374.78 |
| FWE7**45:45:10** | 5.06±0.06a | 3.12±0.02c | 8.03±0.01b | 5.89±0.01c | 40.68±0.02a | 37.22±0.06f | 364.61 |
| Ref  | <10 | <3.00 | <5.0 | 10-25 | >16 | 64 | 344.00 |
| **DOUGH MEAL** |
| FM100 | 20.74±0.04a | 2.53±0.03a | 3.67±0.01d | 1.99±0.01d | 10.46±0.02d | 60.71±0.09a | 320.59 |
| FWE3**80:10:10** | 17.20±0.10b | 2.60±0.01b | 4.74±0.00c | 3.86±0.00c | 17.20±0.00c | 54.38±0.09a | 321.06 |
| FWE5**10:10:80** | 16.69±0.01d | 2.25±0.01b | 3.89±0.01b | 6.71±0.01b | 19.45±0.04b | 50.49±0.08b | 340.15 |
| FWE7**45:45:10** | 19.30±0.10c | 1.07±0.25a | 5.20±0.00a | 7.35±0.05a | 22.05±0.03a | 45.02±0.10c | 334.43 |

*Mean ± standard deviation of three replicate; with the same superscript letter within the same column differ significantly (P< 0.05*)

FM=Finger Millet 100% (CONTROL), FWE3= Finger millet 80%, Wild melon 10%, Eggplant 10%, FWE5= Finger millet 10%,

Wild melon 80%, Eggplant 10%, FWE7= Finger millet 45%, Wild melon 45%, Eggplant 10%.

flour, necessitating the addition of water during the meal's manufacture. The moisture level of the dough meal was much greater than the suggested value of 10.00% by FAO/WHO [28], with a measured value of 20.74, indicating short shelf life stability. Consequently, moisture content over 10.00% tends to decay more rapidly. Edo et al., [29]. The crude ash level of the flour mixes varied from 3.05% to 3.22%. FWE5 had the lowest value at 2.05%, whilst FWE3 demonstrated the greatest value at 5.32%. The dough grain content varied from 0.25% in FWE5 to 1.07% in FEW7. The ash content of a food may indicate the presence or lack of important minerals in a food sample [29, 30]. FWE5 and FWE7 exhibited no statistically significant differences in flour blends. The results obtained in flour were much greater than those in dough meal, likely due to the effects of heat during the gelatinization of starch in dough formation. These findings accord with those of [31], who discovered similar results in roasted African yam beans (1.5-2.5%).
 The crude fiber content of the flour mixes varied from 2.70% to 8.93%. FWE5 demonstrated a better value of 8.93%, whereas dough meal varied from 3.67% in FM to 4.74% in FEW3. This suggests that the inclusion of eggplant and wild melon may contribute to the maximum fiber content of flour and dough meal. High-fiber diets are considered to improve gastrointestinal system functions [32]. However, the value derived from dough meal is lower than that from flour mixes. The impact of heat on dough meal resulted in elevated FWE7 levels, albeit they were reduced in comparison to the recommended daily fiber consumption of 14 g/kcal as per [28]. The high fiber content in composite flour will improve digestion and alleviate constipation linked to items made from refined grain flours [33, 34]. Nevertheless, integrating the dough meal with other foods, such as vegetable soup, would enhance the intake of nutritional fiber. Recent research [35] indicates that dietary fiber intake enhances glucose and lipid absorption in the small intestine, slows stomach emptying, sustains satiety levels, and contributes to reduced weight gain.
The crude fat percentage of flour mixes varied from 1.82% to 7.30%. FM recorded the minimum value at 1.82%, whereas FWE5 exhibited the maximum value at 7.30%. The dough grain content varied from 0.86% in FWE3 to 5.35% in FWE7. Fat is a crucial component utilized to enhance energy density in the formulation of fortified blended foods for at-risk populations. The fat level observed in this study exhibited a similar pattern to that reported in [30] (5.06 – 10.21%), which focused on germinated brown rice flour. The findings indicate elevated fat content in FWE5 (flour) and FWE7 (dough meal). Despite remaining under the WHO norm (10-15%) for food. The elevated fat content observed in FWE5 (flour) and FWE7 (dough meal) in this study may account for the significant proportion of wild melon incorporation. This is advantageous from a health perspective, as it supplies adequate calories to perform everyday tasks [36, 37]. Increased fat content has been shown to improve the palatability of food [30].

 The protein concentration in flour mixes varied between 14.92% and 40.76%. FM had the lowest value at 14.92%, but FWE5 and FWE7 demonstrated the highest value at 40%. The protein level in FWE5 and FWE7 composite flour exceeded that of other composite flours. The result achieved surpasses that of Fatoumata et al. [27], who reported a protein value of 18.09 – 25.12% in the supplementation of millet with cowpea and Bambara groundnut mixtures.

The dough meal varied from 10.46% in FM to 22.05% in FWE7. The observed increase in protein levels in this study resulted from the introduction of wild melon. FM exhibited the lowest percentage (10.46%) in both flour and dough meal, whereas FWE7 had the highest percentage (22.05%) in dough meal. There is a steady decrease in protein content of the meal compared to flour blends, which may be attributed to protein denaturation during cooking. The protein content of the dough meal was significantly different (P≤0.05). Protein is a crucial component essential for optimal infant development. This report exceeds the daily protein requirement for children aged 3 to 7 years, which varies from 13 to 26 grams per day [38]. This indicates that the protein in this study sufficiently meets the body's daily protein requirements. Since The recommended daily protein intake is 0.8 grams, according to [26]. The outcome surpasses the findings of Khetarpaul [39], who documented a porridge made from a soy-sorghum grits composite (9.64).

The carbohydrate content of the flour mixes varied from 36.51% to 73.11%. FWE5 recorded the lowest score at 36.51%, whereas FM exhibited the greatest value at 73.11%. The dough meal constitutes between 45.02% of FWE7 and 60.71% of FM. The FWE7 exhibited the lowest mean value at 45.02%, whereas the FM sample recorded the greatest value at 60.71%. The results indicated substantial differences (P≤0.05) compared to others. The disparity in carbohydrate content of flour meal in flour and composite dough may result from variations in the levels of other constituents, including protein, fat, and ash. The decrease in carbohydrate content in composite dough meal is significant for diabetic individuals [40].

 The energy content of flour blend and dough meal varies from 364.61 kcal in FWE7 to 384 kcal in FWE3 (flour), whereas dough meal ranges from 320.59 kcal in FM to 340.15 kcal in FWE5. FM exhibited the lowest energy value at 320.59 Kcal, but FWE5 demonstrated the greatest energy value at 340.15 Kcal, indicating that FWE5 possesses sufficient capacity to generate calories when appropriately ingested. The difference in the calorie value of dough meal is significant to the ratios of fat, protein, and carbohydrate content in the meal. It generates fewer calories in comparison to the 2200 – 2800 kcal recommended dietary allowance for energy consumption in adults [26]. However, it contains significantly more flour than dough meal and exceeds the required limit of 344Kcal.
**3.2 Mineral and phytonutrient contents (Mg/100g) and molar ratios of dough meal derived from blends of finger millet, wild melon, and eggplant flour**
Table 2 presents the mineral and phytonutrient composition, as well as the molar ratio, of the dough meal. The mineral richness of FWE7 surpasses that of other samples, particularly FM, which has the lowest mineral content. This signifies that FWE7 is a preeminent supply of minerals for the body compared to others. The high mineral concentration in FWE7 demonstrates its ability to maintain normal cellular homeostasis and regulate fluid, electrolyte, and blood pressure balance in the body Dai and Chau [43]. FWE7 may also function as an exceptional supplier of calcium for growing children, expectant mothers, and elderly persons. The elevated concentrations of Na, K, Ca, P, Mg, Fe, and Zn in FWE7 may be ascribed to the incorporation of wild melon and eggplant, with the exception of Mn and Cu, which are more abundant in FWE5. Na concentration varies from 12.70 mg in FM to 18.10 mg per 100g in FWE7 in comparison to others. Potassium (K) concentration varied between 13.30 and 31.50 mg/100g. Calcium content varied from 96.80 to 123.60 mg per 100 grams. The phosphorus concentration varied from 406.30 mg/100g in FWE3 to 684.60 mg/100g in FWE7. Magnesium content varied from 36.40 mg/100g in FM to 47.20 mg/100g in FWE7. The iron level varied from 16.47 mg/100g in FM to 27.77 mg/100g in FWE7. The manganese level varied from 11.40 mg/100g in FWE7 to 19.50 mg/100g in FWE5. Zn concentration varied from 2.02 mg/100g in FM to 6.98 mg/100g in FWE7. Cu varied from 0.88 mg/100g in FEW7 to 2.10 mg/100g in FWE5. The Ca/p ratio varied from 0.18 in FWE7 to 0.24 in FM. Despite the values above the recommended threshold, the data collected remained within the range identified by [41, 42]. The dough meal may provide nutritional advantages for children, who require elevated levels of calcium and phosphorus for the construction and maintenance of bones and teeth. Dai and Chau [43] indicated that a Ca/p ratio exceeding 1 is optimal, whereas lower ratios may lead to detrimental health effects, including arterial calcification, bone loss, and even

**Table 2:** **Mineral, phytonutrient compositions (Mg/100g) and molar ratio of dough meal from blends of finger millet wild melon and eggplant flour**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SAMPLE | **FM****100**  | **FWE3****80:10:10** | **FWE5****10:10:80** | **FWE7****45:45:10** |
| Sodium (Na)  | 12.70±0.01d | 13.00±0.04c | 15.70±0.01b | 18.10±0.02a |
| Potassium (K)  | 13.30±0.03d | 17.70±0.01c | 21.70±0.02b | 31.50±0.01a |
| Calcium (Ca)  | 96.80±0.02d | 108.80±0.05c | 120.40±0.02b | 123.60±0.05a |
| Phosphorus (P) | 406.30±0.05d | 526.40±0.03c | 602.40±0.05b | 684.60±0.10a |
| Magnesium (Mg) | 36.40±0.05d | 41.20±0.02c | 45.00±0.01b | 47.20±0.02a |
| Iron (Fe)  | 16.47±0.01d | 19.87±0.02c | 22.17±0.05b | 27.77±0.01a |
| Manganese (Mn)  | 15.90±0.01c | 18.20±0.02b | 19.50 ±0.01a | 11.40±0.01d |
| Zinc (Zn)  | 2.02±0.01d | 2.45±0.00c | 4.02±0.01b | 6.98±0.01a |
| Copper (Cu)Ca/P  | 1.23±0.01b0.24 | 1.88±0.01b0.21 | 2.10±0.01a0.20 | 0.88±0.01c0.18 |
| Na/K | 0.95 | 0.76 | 0.72 | 0.88 |
| Phytate (mg/100g) | 20.18±0.03c  | 23.20±0.07b | 16.12±0.00d | 28.13±0.06a  |
| Oxalate (mg/100g) | 32.17±0.10d | 44.12±0.03b | 35.33±0.12c | 47.79±0.14a  |
| Tannin (mg/100g) | 7.23±0.02b | 6.23±0.03d | 10.33±0.01a | 9.21±0.02c |
| Alkaloid %  | 1.22±0.01d | 1.18±0.01c | 1.98±0.00b | 2.30±0.01a |
| Saponin(mg/100g) | 33.40±0.30c | 31.21±0.10d | 40.24±0.20a | 38.41±0.10b |
| Trypsin inhibitor (mg/100g) | 1.11±0.00d | 2.22±0.00c | 3.33±0.00b | 4.44±0.00a |
| Phytate/Calcium | 0.20 | 0.21 | 0.13 | 0.23 |
| Phytate/zinc | 9.98 | 9.46 | 4.01 | 4.03 |
| Phytate/Iron | 0.28 | 0.45 | 0.71 | 1.01` |

*Mean ± standard deviation of three replicate; with the same superscript letter within the same column differ significantly (P< 0.05*)

Key: FM=Finger Millet 100% (CONTROL), FWE3= Finger millet 80%, Wild melon 10%, Eggplant 10%, FWE5= Finger millet 10%, Wild melon 80%, Eggplant 10%, FWE7= Finger millet 45%, Wild melon 45%, Eggplant 10%, Ca/P= Calcium: Phosphorus Na/K= Sodium: potassium

mortality. A Ca/p ratio <2 enhances calcium absorption in the small intestine, serving as an indicator of bone production, while the World Health Organization recommends a daily allowance ratio of 1.0 [42, 43]. The Na/k ratio varies from 0.72 in FWE5 to 0.95 in FM. The values obtained were below the suggested thresholds for both adults and children, as indicated by Akinyede et al. [42]. Therefore, a Na/K ratio of less than 1 is advantageous as it may assist in lowering blood pressure and mitigating the risk of cardiovascular disease [42]. Consequently, the reduced ratio identified in this study may confer a benefit to hypertension individuals.

The phytate concentration in the sample varied from 16.12 mg/100g in FWE5 to 28.1 mg/100g in FWE7. The elevated phytate level in FWE7 (28.13 mg/100g) may be attributed to the addition of wild melon (19.30 mg/100g), which could have contributed to the increased phytate content in the meal. Increased concentrations of anti-nutrients, such as oxalate, saponin, and phytate, can chelate calcium, magnesium, iron, and zinc, so rendering them inaccessible by forming complexes; the value obtained surpasses that of [7], which indicates a low phytate level (5.12 – 10.13mg/100g) in multigrain porridge. A different researcher documented a low phytate concentration (7.9 mg/100 g) in amaranth grain Soliman, [44]. Consequently, phytate significantly diminishes mineral bioavailability; hence, a low phytate concentration in diet indicates that most minerals present will be accessible for absorption. The value of 28.13 mg/100g for FWE7 is within the recommended daily intake range of 0.18 to 4.57 g/day Soliman, [44]. The oxalate concentration in the sample varied between 32.17 and 47.79 mg/100g. The tannin level of the bread grain varies from 6.23 mg/100g in FWE3 to 10.33 mg/100g in FWE5. The alkaloid content of the dough meal varied from 1.82 mg/100g in FM to 2.30 mg/100g in FWE7. The saponin level of the dough meal varied from 31.21 mg/100g in FWE3 to 40.24 mg/100g in FWE5. Saponins have several health benefits, including immunostimulatory, hypocholesterolemic, anticancer, anti-inflammatory, and antibacterial properties. High consumption of saponin in food can aid in lowering cholesterol levels and decreasing the prevalence of obesity-related disorders. Trypsin inhibition varied from 1.11 mg/100g in 100% finger millet to 4.44 mg/100g in FWE7. The phytate/calcium ratio varied from 0.13 in FWE5 to 0.23 in FWE7. The phytate/calcium ratio indicates the bioavailability of minerals, specifically calcium, in the body. The current results demonstrate that FWE7 can bind a greater amount of calcium for the production of bones and teeth. The phytate/zinc ratio varied from 4.01 in FWE5 to 9.98 in FM. The phytate/zinc ratio in FM was significantly elevated (9.98), indicating that FM possesses a greater capacity to bind zinc, hence enhancing its bioavailability for the body compared to other sources. These results indicate that the use of this product will aid in diminishing the prevalence of zinc insufficiency in the body. Zinc absorption is concentration-dependent and escalates with higher dietary zinc until reaching a maximum rate. The phytate/iron ratio varied from 0.28 in FM to 1.01 in FWE7. The phytate/iron ratio was significantly elevated in sample FWE7 (1.01), indicating that FWE7 possesses a greater capacity to bind iron, hence enhancing its bioavailability for the body compared to others. The low content of anti-nutrients in food is significant from a health perspective. According to Olagunju [7], anti-nutrients can attach to nutrients (proteins, minerals), so obstructing their absorption and use, which ultimately diminishes the nutritional value of the diet [7]. The anti-nutrient levels in the formed meal were markedly elevated compared to those in whole finger millet; concurrently, finger millet has been documented to possess lower anti-nutrient content than wild melon and eggplant [45, 46].

3.4 Impact of in vitro antioxidant scavenging capacity on flour blends and dough meal derived from the combinations of finger millet, wild melon, and eggplant, as seen in Figure 1 below.

Antioxidants are chemical substances that can prevent the oxidation of cellular components, hence averting oxidative stress in the body. The antioxidant activities of flour blends and dough meal derived from the combinations of finger millet, wild melon, and eggplant are illustrated in Figure 1 above. The antioxidant scavenging capacity of the flour (F) against FRAP, phenolic compounds, DPPH, Fe2+ chelation, and nitric oxide (NO\*) and dough meal (D) was concentration-dependent. The results indicated that the flour exhibited decreased activity in FRAP and total phenolic content, except for DPPH, Fe2+ chelation, and NO\*. The capacity of dough grain to neutralize free radicals in relation to Ferric lowering antioxidant power FRAP varied from 50.77 mgAAE/g in FWE3D to 98.23 mgAAE/g in FWE7D; phenolic content ranged from 6.27 mgAAE/g in FWE7 to 8.44 mgAAE/g in FMD; DPPH inhibition was between 54.64% in FWE5D and 73.07% in FEW7D; Fe2+ chelation ranged from 68.97 mg/ml in FWE5D to 84.85 mg/ml in FEW7D; and NO\* levels varied from 63.07 mg/100g in FEW5D to 91.17 mg/100g in FEW7D. Antioxidant scavenging ability was greater in FEW7D than in FEW3D (55.87 mgAAE/g) and FEW5D (83.12 mgAAE/g) when compared to FM, with the exception of total phenolic content. The impact of heat during cooking may be ascribed to the enhanced scavenging capability of dough meal compared to flour; hence, FEW7D possesses a significant capacity to neutralize free radicals that might induce oxidative stress in the body. This outcome parallels the findings of Oluwajuyitan et al. [3] regarding the antioxidant activity of Plantain-based dough meal. Consequently, antioxidants can neutralize free radicals, chelate metal catalysts, activate antioxidant enzymes, diminish α-tocopherol radicals, and inhibit oxidase. The formulated sample, particularly FWE7, exhibits appropriate antioxidant properties; consistent consumption may augment endogenous antioxidant activity to combat the excessive generation of free radicals in the body.

a b



e



**Figure 1: shows effect of *invitro*-antioxidant scavenging ability on flour blends and dough meal from the blends of finger millet, wild melon and eggplant**

FMF=Finger Millet 100% (CONTROL) flour, FMD=Finger Millet 100% (CONTROL) dough meal, FWE3F= Finger millet 80%, Wild melon 10%, Eggplant 10% (flour), FWE3D= Finger millet 80%, Wild melon 10%, Eggplant 10% (dough meal), FWE5F= Finger millet 10%, Wild melon 80%, Eggplant 10% (flour), FWE5D= Finger millet 10%, Wild melon 80%, Eggplant 10% (dough meal), FWE7F= Finger millet 45%, Wild melon 45%, Eggplant 10% (flour). FWE7D= Finger millet 45%, Wild melon 45%, Eggplant 10% (dough meal).

The inhibition of α-Amylase and α-Glucosidase activity in dough meal derived from finger millet, wild melon, and eggplant shown in Figure 2 below.
The α-Amylase inhibition percentage on the dough meal varied from 15.17% in FWE3 to 28.33% in FWE7. There were significant differences (P < 0.05) compared to others. FM exhibited the lowest content (15.17), but FWE7 demonstrated the highest level (28.33). Elevated temperatures (heating) generate resistant starch, which may contribute to increased inhibition in dough meal. The result obtained aligns with the findings of Olugbuyi et al. [48]. Similar results were seen in plantain dough meal (15-30%), where FWE7 shown significant inhibitory capabilities, suggesting its potential for enhancing α-amylase inhibition alongside antioxidant activity, making it advisable for those with hyperglycemia and diabetes. α–Glycosidase catalyzes hydrolysis and promotes glucose absorption [48, 1]. The inhibitory capability of dough meal on α–glycosidase activities varied from 25.32% in FWE3 to 44.59% in FWE7. It follows the same trend as α-Amylase, with FWE3 exhibiting the lowest value (25.32) and FWE7 displaying the greatest value (44.59). A comparable pattern was noted in the work by Olugbuyi et al. [48], who reported analogous variations in the flour and dough derived from plantain and rice bran blends. Consequently, FWE7 has the capacity to control type 2 diabetes mellitus and decrease glucose uptake in the body. The enhanced inhibition of α–Glycosidase in FWE7 may result from the formation of resistant starch and the rupture of starch granules during heating, which retrogrades the starch, rendering it less digestible.

a b

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## Figure 2. The α – Amylase and α – Glucosidase (%) of the dough meal from blends of finger millet wild melon and eggplant flour

## FM=Finger Millet 100% (CONTROL), FWE3= Finger millet 80%, Wild melon 10%, Eggplant 10%, FWE5= Finger millet 10%, Wild melon 80%, Eggplant 10%, FWE7= Finger millet 45%, Wild melon 45%, Eggplant 10%.

**3.7 The dietary fiber content of the dough meal derived from the blends of finger millet, wild melon, and eggplant is presented in Table 3.**

The insoluble dietary fiber varied from 25.35 in FWE5 to 45.03 in FM. FWE5 exhibited the lowest mean value (25.35), but FM demonstrated a higher mean value (45.03). The soluble dietary fiber varied between 10.65 and 15.44. FWE5 had the lowest value at 10.65%, whereas FWE7 demonstrated the highest mean value at 15.44%. Soluble fiber slows digestion and reduces the rate of glucose absorption after ingestion [49]. A diet abundant in insoluble dietary fiber is crucial, since it facilitates digestion, mitigates constipation, and may lower the risk of chronic diseases. The advised daily consumption of total dietary fiber is 25 to 30 grams [49]. Stephen et al. [50] observed that the accumulation of dietary fiber aids in body weight management and enhances overall metabolic function, including its effects on glucose and lipid homeostasis as well as insulin sensitivity. IDF:SDF exhibits a reduced value in dough meal 2:1 relative to 100% finger millet 3:1 and the commercial sample 5:1, while the values align with the WHO norm of 2:1 suggested for a daily meal. This indicates that prepared dough meals are beneficial sources of dietary fiber for the body when comparing the IDF:SDF ratio of FM (3:1) to that of the commercial sample (5:1).

## Table 3 Dietary fibre of Dough meal from blends of finger millet wild melon and eggplant flour

|  |  |  |  |
| --- | --- | --- | --- |
| Sample  | Insoluble  | Soluble  | IDF:SDF |
| FM100 | 45.03±0.05 | 12.27±0.12c | 3.1 |
| FWE3**80:10:10** | 32.18±0.01 | 13.32±0.01b | 2:1 |
| FWE5**10:10:80** | 25.35±0.03 | 10.65±0.02d | 2:1 |
| FWE7**45:45:10** | 38.56±0.02 | 15.44±0.05a | 2:1 |

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at (*P* < 0.05): Key: FM=Finger Millet 100% (CONTROL), FWE3= Finger millet 80%, Wild melon 10%, Eggplant 10%, FWE5= Finger millet 10%, Wild melon 80%, Eggplant 10%, FWE7= Finger millet 45%, Wild melon 45%, Eggplant 10%, IDF= insoluble dietary fiber, SDF= soluble dietary fiber.

3.7: The glycemic index and glycemic load of dough-based meals are presented in Table 4.

The dietary glycemic index (GI) serves as a measure of carbohydrate quality, indicating its impact on blood glucose levels. Foods are often categorized into three classifications: high GI (>70%), medium GI (56-69%), and low GI (<55%). The glycemic index of dough meal varied from 38.00% in FWE7 to 49.25% in FWE5. The glycemic load of dough meal ranged from 21.24% in FWE7 to 31.53% in FWE3, in comparison to glucose (control) at 100%. This finding indicated that the glycemic index (GI) and glycemic load (GL) of FWE7, composed of 45% finger millet, 45% wild melon, and 10% eggplant, were significantly lower compared to FM, FWE3, and FWE5 Despite all samples being classified as low glycemic index and moderate glycemic load foods, as they are below 56%, FWE7 exhibited a reduced GI and GL. This suggests that the dough meal, with 45% finger millet and wild melon, has an enhanced capacity to rapidly lower blood glucose levels in diabetic individuals. Numerous researches [51, 7] have indicated that the consumption of low glycemic index (GI) and glycemic load (GL) foods typically diminishes the risk of diabetes, enhances insulin sensitivity, and may even lower serum cholesterol levels [3]. Consequently, the low glycemic index (GI) and glycemic load (GL) values seen in the FWE7 food samples may facilitate a rapid decrease in consumers' blood glucose levels.

## Table 4: Glycemic index and load (%) of dough meal

|  |  |  |
| --- | --- | --- |
| Sample  | Glycemic index  | Glycemic load  |
| FM100 | 41.41 | 29.61 |
| FWE3**80:10:10** | 42.83 | 31.53 |
| FWE5**10:10:80** | 49.25 | 31.15 |
| FWE7**45:45:10** | 38.00 | 21.24 |
| GLUCOSE (CONTROL) | 100 | - |

Key Finger Millet 100% (CONTROL), FWE3= Finger millet 80%, Wild melon 10%, Eggplant 10%, FWE5= Finger millet 10%, Wild melon 80%, Eggplant 10%, FWE7= Finger millet 45%, Wild melon 45%, Eggplant 10%.

**4.0 CONCLUSION**

 The study determined the proximate composition and antioxidant properties of various flours to evaluate their quality. The protein content ranged from 37% to 40%, and antioxidant properties exceeded 70 in the formulated blends. Among the four samples assessed, FWE7 (45% Finger millet: 45% Wild melon: 10% Eggplant) demonstrated significant levels of crude fiber, protein, and phytochemicals. Its high antioxidant content, dietary fiber, α-Amylase, and α-glucosidase indicate its potential to scavenge free radicals that can damage tissues. Additionally, the results suggest it may enhance insulin sensitivity and reduce glucose uptake in the body. Notably, the low glycemic index/load values indicate its suitability as a functional food for diabetes management when consumed appropriately.

Data Availability: The datasets examined in this study will be accessible from the corresponding author upon reasonable request.

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