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Research Article

Enriched Cake Production and Optimisation of Physicochemical Qualities of Wheat, Moringa Seed and African Oilbean Composite Flours

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Abstract

The increased consumer interest in functional food in recent times cannot be over emphasized. Hence, this study developed functional wheat based snack (cake) supplemented with *Moringa* seed and African oil bean seed flours. The experimental design was carried out using optimal mixture model of response surface methodology. The responses were moisture, protein, crude fat, crude fiber, ash and carbohydrate contents. The results of the ANOVA, R^2 and adjusted R^2 values showed that the protein, crude fibre and ash contents were particularly significant ($p \leq 0.05$). The optimum blends were run 1 (81.20% wheat, 8.68% *Moringa* seed and 10.12% African oil bean flours), run 11 (50%Wheat 25% *Moringa* seed and 25% African oil bean seed flours) and run15 (90%Wheat 5% *Moringa* seed 5% African oil bean seed flours).

Run 1 compared favourably with the control (100% wheat) with respect to its functional properties and the pasting properties. The cake prepared compared favourably with cake from the control with respect to its physical and sensory properties. The results of the proximate, functional, and pasting properties indicates that composite flours with acceptable and excellent nutritional compositions, and pasting behaviour can be obtained from composite blends consisting wheat, *Moringa* seed and African oil bean seed flours.

Keywords: ANOVA; Composite Flour; Functional; Pasting; Proximate; Response Surface Methodology

Introduction

Production of functional bakery products [1] is on the increase, hence the use of composite flour consisting locally grown crops to replaces a portion of wheat flour is common in many developing countries. This will reduce the demand for imported wheat and stimulate production and use of locally grown non-wheat agricultural products [2]. It also improves consumer diet and prevents ailments such as cancer, cardiovascular disease and obesity [3]. Natural raw materials rich in dietary fibre (DF) and high in antioxidant capacity are functional ingredients for the food industry [4]. African oil bean is a cheap source of protein and phytochemicals [5]. *Moringa oleifera* is also well known for its nutritional and medicinal values due to its phytochemical and chemical composition [6]. Wheat is the third most produced cereal in the world after maize and rice [7] and it is a very important for the daily intake of proteins, vitamins, minerals and fibers in a growing part of the world population [8]. Response Surface Methodology (RSM) creates response-surface models for the prediction of changes in response variables as a function of changes in input variables [9]. Response surface methodology had been utilized in statistical optimization of nutritional properties of composite flours production [1,3]. Response surface 3D plots help in visualizing the parameters interactions between the variables and the responses [1,3,10]. This study is therefore aimed at optimizing the production of functional composite flour from wheat, *Moringa* seed and African oil bean seed flours; assess its nutritional quality and its pasting properties in order to determine its nutritional suitability cake preparation.

Materials and Methods

Sample Collection

The African oil bean seeds were purchased from Owena market in Western Nigeria. The *Moringa* seeds were obtained from Akure. Wheat flour and other baking ingredients were purchased from Oba market in Akure while all reagents used were of analytical grade.

Preparation of African Oil Bean Seed Flour:

The brown hard seed coats of the seeds were manually removed and the cotyledons sliced. The slices were then dried for 8 h at 95°C in a laboratory oven (Model No DHG-9101.ISA) (made in

China), and comminute with a laboratory type hammer mill PX-MFC 90D (made in Japan) into fine particle size (210 µm). The flour was then preserved in dry air tight jars at -4°C prior to use [11].

Preparation of Moringa Seed Flour:

The method of [12] was adopted in *Moringa* seed flour production. Good quality dry seeds of *Moringa Oleifera were* selected while the seed coat and wings were removed manually. The kernel was ground to fine powder using the coffee mill attachment of the Mickachi domestic food blender (Model: MK- 9876) and then sieved through 210 µm sieve.

Experimental Design

Optimal Mixture model of response surface methodology (RSM) (Design expert 8.0.3.1 trial version) was used for the experimental design. The variables were wheat flour (50-90 g/100g), *Moringa* seed flour (5-25 g/100g) and African oil bean (5-25 g/100g) while the response was: proximate properties (moisture, protein, crude fat, crude fibre, ash and carbohydrate).

Proximate Analyses of Composite Flour

This was carried out using Association of Official Analytical Chemists [13] methods in order to determine the percentages of moisture, protein, crude fibre and fat content of the flour blends while carbohydrate content was determined by difference using the method of [14].

Functional Properties of Composite Flour

Water Absorption Capacity

This was determined using the method of [15] with some modifications. About 0.5g sample was dissolved with 10 mL of distilled water in centrifuge tubes and vortexes for 30 sec. The dispersions were allowed to stand at room temperature for 30 min and centrifuged at 3,000 rpm for 25 min. The supernatant was filtered with what man Number 1 filter paper and the volume retrieved was accurately measured. The difference between initial volumes of distilled water added to the sample and the volume obtained after filtration was determined. The results were reported as mL of water absorbed per gram of sample. The water absorption capacity was calculated as shown in Equation [1].

Water Absorption Capacity = Amount of water absorbed/Weight of sample [1]

Oil Absorption Capacity

Oil absorption capacity (OAC) was determined using the method of Chakraborty, (1986). One gram of the sample (W_0) was weighed into pre-weighed 15 mL centrifuge tubes and thoroughly mixed with 10 mL of refined pure groundnut oil using vortex mixer. Samples were allowed to stand for 30 min and centrifuged at 3,000 rpm for 20 min. The supernatant was carefully poured into a 10 mL graduated cylinder, and the volume was recorded (V_2). Oil absorption capacity (milli liter of oil per gram of sample was calculated as shown in Equation [2].

$$\text{Oil Absorption Capacity} = (V_1 - V_2)/W_0 \qquad [2]$$

Bulk Density

This was determined using the method of [16]. About 20g of sample was weighed into 100 ml graduated cylinder. The cylinder was tapped 100 times and the packed bulk density was calculated as weight of sample per volume occupied as shown in Equation [3].

Bulk density = weight of sample/volume occupied after tapping [3]

Foaming Capacity and Foaming Stability

These were determined by the method of [16]. Two grams (2g) of flour sample was weighed into a foaming capacity cylinder and 50 ml of distilled water was added at 30±2 oC. The suspension was mixed properly, shaken to foam and the volume of the foam after 30s was recorded. The foaming capacity was expressed as a percentage increase in volume. The foam volume was recorded 1h after whipping to determine the foam stability (FS) as a percentage of the initial volume.

Pasting Properties

Pasting properties were determined using the method of AACC 2000. The rapid visco analyser (RVA) was used. The composite flour sample (3.5g) was weighed and dispensed into the test canister. Distilled water (25.0 ml) was thereafter dispensed into the canister (14% moisture basis). The visco analyser was switched on and the pasting performance of the flour was automatically recorded on the graduated sheet of the instrument.

Cake Production

The margarine and sugar were creamed manually for 5 min in a bowl until soft and fluffy. The egg was beaten for 3 min, added to the mixture and mixed manually for 5 min. Flour samples from various composite blends were separately sieved, and baking powder was added and mixed thoroughly by hand until soft dough was formed. The dough was transferred to a greased baking pan and baked in a preheated oven at 200°C for 30 min [17].

Proportion of Ingredients

The proportion of ingredients used consists of flour (100g), sugar (62.5g), margarine (62.5g), baking powder (5.7g) and vanilla essence (three drops), as described by [17].

Physical Properties of Cake

Batter Density Determination

The batter density of cakes was determined as described by [18]. A container of known weight (W_1) was first filled with batter and the weight of batter was obtained as (W_T-W_1). Then, the same container was filled with distilled water and the volume of the water was determined (V_w). Batter density was determined as the ratio of the weight of a standard container filled with batter to that of the same container filled with water and expressed in g/cm^3 using Equation [4].

$$\text{Batter Density} = (W_T - W_1)/V_w \qquad [4]$$

Volume Determination

The final cake volume was obtained using the rapeseed displacement method as described by (AACC, 1990). The cake was cut into 25 x 25 x 25 mm cubes. Then one piece of cake was weighed (W_o), placed in a container and the rest of the container volume was filled with rapeseed (V_2). The volume of the empty container (V_1) was calculated by filling with rapeseed. Both (V_1) and (V_2) were later determined by a graduated cylinder and the difference between V1 and V_2 was reported as the cake volume (V_o).

Volume Index Determination

This was measured according to [19]. In this method, the cake is cut vertically through the center and the heights of the cake sample were measured at three different points (B, C and D) along the cross sectioned cake using the template. Volume index was then determined using Equation [5].

$$\textit{Volume index} = B + C + D \qquad [5]$$

Where:

B = Height of the cake at the point 2.5 cm away from the centre toward the left side of the cake.

C = Height of the cake at the centre point,

D = Height of the cake at the point 2.5 cm away from the centre toward the right side of the cake.

Weight Determination

Weight of cake was determined using an electronic digital balance (Ohaus to load, model: Adventurer Pro AV8101).

Sensory Evaluation of Cake

Sensory evaluation of cake samples were carried out using the method described by [20]. A 30-membered untrained panel consisting of students of Food science and Technology department of Federal University of Technology Akure, was selected for sensory evaluation. Cake samples prepared from each flour blend were presented in coded form in white plastic plates. The order of presentation of samples to the panel was randomized. Tap water was provided to rinse the mouth between evaluations. The pane lists were instructed to evaluate the coded samples for crumb colour, crust colour, texture, aroma, taste and overall acceptability. Each sensory attribute was rated on a 9-point hedonic scale (1 = disliked extremely, while 9 = liked extremely).

Results and Discussion

Proximate Composition of Composite Flour

The moisture content of the flour formulations ranged from 6.12 to 8.62g/100g. Low moisture content of wheat flour retards mould growth and other biochemical reactions and enhance storage stability [21]. The model (special quartic) and model terms (linear mixture, AB^2C) are significant ($P \leq 0.05$). The R^2 and the adjusted R^2 values were 0.9349 and 0.8604 respectively which indicate good model fitting [1]. The contour plot showing the interactions between the variables (Wheat flour, Moringa seed flour and African oil bean seed flour) and response (moisture) is shown in Figure 1a and it indicates that the bulk of moisture in the composite flour was from wheat flour.

Figure 1a: Contour plot showing the interactions between the variables with the response (moisture).

The final equation representing the effect of the variables on moisture is given in Equation [6].

$$\text{Moisture} = 8.55A + 10.55B + 5.23C - 8.75AB + 1.94AC - 4.24BC + 80.85A^2BC - 107.28AB^2C + 2.22ABC^2 \qquad [6]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

The ash content of the flour blends ranged from 0.73 - 1.55g/100g. *Moringa* seed and African oil bean seed flour contributed largely to total ash content as both have higher ash content than wheat flour with regards to past researches. While *Moringa* seed flour contain 5% ash content [22,23] reported 1.50% ash content in African oil bean seed flour. Soft wheat flour has however been reported by [24] to be low in ash with a value of 1.00%. High ash content is indicative of more mineral elements in the flour blends which could be of immense benefits to the body.

The R^2 and the adjusted R^2 values were 0.9725 and 0.9411 respectively. The contour plot showing the interactions between the variables (Wheat flour, *Moringa* seed flour and African oil bean seed flour) and response (ash) is shown in Figure 1b and it indicates that *Moringa* seeds and African oil bean actually contributed largely to the ash content of the flour than wheat flour. The model (special quartic) and model terms (linear mixture, AC, BC, A2BC) were significant ($P \leq 0.05$).The final equation representing the effect of the variables on ash is given in Equation [7].

Figure 1b: Contour plot showing the interactions between the variables with the response (ash).

$$Ash=0.89A + 0.11B - 1.59C + 1.04AB + 6.20AC + 7.84BC + 17.82A2\,BC - 12.10AB2\,C - 10.18ABC2 \quad [7]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

The crude protein content ranged from 22.56 - 30.11 g/100g for the flour samples. The values obtained are indicative of high protein content in the blends. *Moringa* seed and African oil bean seed flour contributed largely to the protein content as both have been reported to have higher protein content than wheat flour. While *Moringa* seed contain between 29.36 - 34.45% crude protein [5,25] reported that African oil been seed flour contained 21.65% crude protein.

Wheat flour lacks certain essential amino acids such as lysine, tryptophan and threonine [26]. Vegetable products largely legumes are sources of dietary proteins hence several legume-based foods are been developed to alleviate protein calories malnutrition problem [27]. Composite flours are thus advantageous in that inherent deficiencies of essential amino acids in wheat flour (lysine, tryptophan and threonine) are supplemented from other sources like legumes [28]. The model (special quartic) and model term (linear mixture) are significant ($P \leq 0.05$). The R^2 and the adjusted R^2 values were 0.8947 and 0.7744 respectively. The contour plot showing the interactions between the variables (Wheat flour, *Moringa* seed flour and African oil bean seed flour) and response (protein) is shown in Figure 1c and it is also indicative of the high protein content been contributed by *Moringa* seed and African oil bean. The final equation representing the effect of the variables on protein is given in Equation [8].

Figure 1c: Contour plot showing the interactions between the variables with the response (protein).

$$Protein = 22.81A + 27.90B + 37.85C + 3.22AB - 12.34AC - 10.73BC - 22.12A^2\,BC + 62.00AB^2\,C - 37.46ABC^2 \quad [8]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

Fat content of flour blends ranged from 10.64 - 25.79g/100g. [22] reported that Moringa seed contained 40.00% fat while [29] reported 47.90% fat content in African oil bean flour.

According to the report of [30] wheat flour has 0.82% of fat. Thus, Moringa seed flour and African oil bean seed flour has contributed largely to the fat content in the flour blends. Flours high in fats have been reported by [31] to be good flavor enhancers and useful in improving palatability when incorporated in foods. The model (special quatic) and model term (linear mixture) are significant ($P \leq 0.05$). The R^2 and the adjusted R^2 values were 0.9810 and 0.9593 respectively which shows a good fitting model. The contour plot showing the interactions between the variables (Wheat flour, Moringa seed flour and African oil bean seed flour) and response (fat) is shown in Figure 1d and it indicates that Moringa seed and African oil bean contributed more fat to the composite flour than wheat flour did. The final equation representing the effect of the variables on fat is given in Equation [9].

Figure 1d: Contour plot showing the interactions between the variables with the response (fat).

$$Fat= 10.60A + 17.24AB + 38.18C - 2.08AB - 21.00AC - 8.37BC + 8.81A^2\,BC + 282.64AB^2\,C - 242.53ABC^2 \quad [9]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

The crude fiber content of the flours ranged from 0.72 - 0.82g/100g. Low crude fiber (0.51%) was reported by [24] for wheat flour but the values obtained from the composite flour was however higher than that of wheat flour. There are no significant model terms which could indicate that the raw materials are not good sources of fibre and it also reflects in the values of the R^2 and the adjusted R^2 values been 0.7517 and 0.3793 respectively. The contour plot showing the interactions between the variables (Wheat flour, *Moringa* seed flour and African oil bean seed flour) and response (fiber) is shown in Figure 1e and it shows that each of the flour contain fractions of fibre hence the value obtained in the composite flour. The final equation representing the effect of the variables on fiber is given in Equation [10].

Figure 1e: Contour plot showing the interactions between the variables with the response (fiber).

$$\text{Fiber} = 0.75A - 4.72B + 3.95C + 10.93AB - 6.33AC + 4.66BC - 6.21ABC - 8.01AB(A - B) + 5.20AC(A - C) + 9.28BC(B - C) \quad [10]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

The carbohydrate values of the flour sample ranged between 35.28 - 56.51g/100g. The carbohydrate content of wheat flour was 77.55% as reported by [32]. This then implies that wheat flour is the sole contributor to the carbohydrate content. However, the carbohydrate content of the composite flour was reduced due to the inclusion of *Moringa* seed and African oil bean hence capable of combating hunger, protein-energy malnutrition and enhances the use of underutilized indigenous crops in ensuring food security. The model (special quratic) and model terms (linear mixture, AC, AB2C, ABC2) were significant ($P \leq 0.05$). The R^2 and the adjusted R^2 values were 0.9988 and 0.9974 respectively which shows a good fitting model. The contour plot showing the interactions between the variables (Wheat flour, Moringa seed flour and African oil bean seed flour) and response (carbohydrate) is shown in Figure 1f and it further indicated that the carbohydrate content of the composite flour was largely contributed by wheat flour. The final equation representing the effect of the variables on carbohydrate is given in Equation [11].

Figure 1f: Contour plot showing the interactions between the variables with the response (carbohydrate).

$$\text{Carbohydrate} = 56.42A + 44.30B - 20.22C + 4.93AB + 23.99AC + 12.08BC - 79.60A^2BC - 204.48AB^2C + 282.15ABC^2 \quad [11]$$

Where A = wheat flour, B = *Moringa* seed flour, C = African oil bean seed flour

Optimized Blends

The best three blends from the optimization of proximate composition are Run 1 (81.20%Wheat, 8.68%*Moringa* seed and 10.12% African oil bean seed flours), Run 11 (50%Wheat, 25%*Moringa* seed and 25%African oil bean seed flours) and Run 15 (90%Wheat, 5%*Moringa* seed and 5%African oil bean seed flours). These runs had the overall best proximate composition.

Functional Properties of Optimized Flour Blend

The results of functional properties for selected optimized flour blends are presented in Table 1. The bulk density ranged from 0.84 g/cm^3 in sample A (100% wheat flour) to a range of 0.63 - 0.72 g/cm^3 in the composite flour blends with Run 11 having the least value while Run 1 had the highest value. The result for 100% wheat flour (sample A) was close to the report of [33] who reported 0.78 g/cm^3 for wheat flour and the values obtained for the composite blends were also close to the range (0.65 - 0.73 g/cm^3) reported by [33] for African oil bean flour substitution in wheat/African oil bean seed flour. Bulk density has direct influence on packaging requirement and material handling [34]. Low bulk density of the flours is advantageous when determining transportation cost and space requirement; since less space will be required for packaging of the flours.

Samples	WAC (ml/g)	OAC (ml/g)	Bulk density (g/cm^3)	Foam capacity (%)	Foam stability (%)
A	1.20 ± 0.00^{ab}	1.50 ± 0.10^{a}	0.84 ± 0.01^{a}	15.09 ± 0.02^{a}	5.66 ± 0.02^{b}
Run 1	1.10 ± 0.10^{b}	1.40 ± 0.00^{ab}	0.72 ± 0.01^{b}	7.69 ± 0.02^{d}	5.79 ± 0.02^{a}
Run 11	1.10 ± 0.10^{b}	0.90 ± 0.10^{c}	0.63 ± 0.01^{d}	9.43 ± 0.02^{c}	5.66 ± 0.02^{b}
Run 15	1.30 ± 0.10^{a}	1.30 ± 0.10^{b}	0.67 ± 0.01^{c}	9.62 ± 0.02^{b}	5.79 ± 0.02^{a}

Means of triplicate determinations ± S.D

Means with different superscripts on the same column are significantly different at $p \leq 0.05$

A = 100%Wheat flour (Control)

Run 1 = 81.20%Wheat flour/8.68%*Moringa* seed flour/10.12% African oil bean seed flour

Run 11 = 50%Wheat flour/25%*Moringa* seed flour/25%African oil bean seed flour

Run 15 = 90%Wheat flour/5%*Moringa* seed flour/5%African oil bean seed flour

Table 1: Functional Properties of Optimized Flour Blend

The water absorption capacity exhibited by sample A (100% wheat flour) was 1.20 ml/g while the composite flour blends ranged between 1.10 - 1.30 ml/g. Run 1 and Run 11 had the least value while Run 15 had the highest.

The oil absorption capacity for the 100% wheat flour was 1.50 ml/g while a range of 0.90 - 1.40 ml/g was exhibited by the composite flour blends. The oil absorption capacities of the flour blends showed a reduction compared with the 100% wheat flour and this could be as a result of the inclusion of African oil bean seed flour and *Moringa* flour as African oil bean contains more fat than wheat flour [35] observed a range of 1.23 - 1.57 g/g oil absorption capacity in wheat - amaranth seed - brewers' spent grain - apple pomade composite flour and explained that high oil absorption capacity indicates the enhanced hydrophobic character of proteins in the flours. The mechanism of fat absorption could be linked to the physical entrapment of oil and the binding of fats to the a polar chain of protein [36] hence the oil entrapment of the flours were reducing probably as a result of the high fat content of African oil bean and *Moringa* seed compared with wheat.

The foaming capacity recorded for wheat flour was 15.09% while that of the flour blends range between 7.69 - 9.62% which reflects a reduction compared with the 100% wheat flour; this could be attributed to the high fat content (47.90%) of the African oil bean flour reported by [29] and lipids have been shown to be foam depressants [37]. There was significant difference ($p \leq 0.05$) in the values recorded for all the samples.

The foam stability for sample A was 5.66% while that of the flour blends ranged between 5.66 - 5.79%. The foam stability for samples A and Run 11 were the same (5.66%) while that of Run 15 and Run 1 were also the same (5.79%). [33] inferred that flours with higher protein content could account for high foam stability hence the increase in foam stability of Runs 1 and 15 could be attributed to the increased amount of protein in the composite flour due to the incorporation of African oil bean.

Pasting Properties of Selected Optimized Flour Blends

The pasting properties for wheat flour (sample A) and selected optimized flour blends are presented in Table 2. The peak viscosity, trough, Breakdown, Final viscosity, setback and peak time all decreased from sample A (100% wheat flour) to the composite blends except the pasting temperature that had gradual increase. There were significant ($p \leq 0.05$) differences in all the samples. The peak viscosity decreased from 1616 RVU in the control to a range of 256 - 1228 RVU in the composite blends and the peak time required to reach peak viscosity ranged from 6.07 min in the control to 5.20 - 5.87 min in composite blends. [38] also observed similar (5.87 - 5.93 min) peak time for wheat-cocoyam-bambara groundnut composite flour. This reduction could be attributed to reduce starch gelatinization as African oil bean and *Moringa* seed contains less starch compared with wheat flour. A reduction in peak viscosity of wheat flour substituted with chicken pea flour was also reported by [39] and this was attributed to reduced carbohydrate content and different protein content affecting viscosity parameter. [40] also reported a decrease in peak viscosity of wheat flour substituted with germinated *Moringa* flour and this was attributed to the amylase activity in germinated *Moringa* flour.

Samples	Peak Viscosity (RVU)	Trough (RVU)	Breakdown (RVU)	Final viscosity (RVU)	Setback (RVU)	Peak time (Min)	Pasting temperature (°C)
A	1616 ± 2^{a}	936 ± 2^{a}	680 ± 1^{a}	1906 ± 2^{a}	970± 2^{a}	6.07 ± 0.02^{a}	88.85 ± 0.02^{d}
Run **1**	948 ± 2^{c}	499 ± 1^{c}	449 ± 1^{c}	1296 ± 2^{c}	797 ± 2^{c}	5.80 ± 0.02^{b}	90.50 ± 0.02^{b}
Run **11**	256 ± 2^{d}	131 ± 2^{d}	125 ± 2^{d}	390 ± 1^{d}	259 ± 2^{d}	5.20 ± 0.02^{b}	93.70 ± 0.02^{a}
Run **15**	1228 ± 2^{b}	659 ± 1^{b}	569 ± 1^{b}	1580 ± 1^{b}	921 ± 2^{b}	5.87 ± 0.02^{b}	89.65 ± 0.02^{c}

Means of triplicate determinations ± S.D

Means with different superscripts on the same column are significantly different at $p \leq 0.05$

A = 100%Wheat flour (Control)

Run 1 = 81.20%Wheat flour/8.68%*Moringa* seed flour/10.12% African oil bean seed flour

Run 11 = 50%Wheat flour/25%*Moringa* seed flour/25%African oil bean seed flour

Run 15 = 90%Wheat flour/5%*Moringa* seed flour/5%African oil bean seed flour

Table 2: Pasting Properties of Optimized Flour Blends

Peak viscosity is often correlated with the final product quality and it is also an indication of the viscous loads likely to be encountered during mixing [41]. The breakdown viscosity (peak viscosity - trough) significantly decreased from 680 RVU in sample A (100% wheat flour) to a range of 125 - 569 RVU in the composite flours. A decrease in breakdown was also reported by [40] of wheat flour substituted with germinated *Moringa* flour. Breakdown viscosity is a measure of degree of disintegration of granules of cooked starch and higher breakdown viscosity results in higher starch instability [42]. The values of setback decreased from 970 RVU in sample A (100% wheat flour) to 259 - 921 RVU as wheat flour content of the composite flours were reduced. Reduced setback has been reported to be advantageous because it is an indication that the starch has a low tendency to retrograde or undergo syneresis during freeze thaw cycles [43,44]. The pasting temperature of the flours significantly ($p \leq 0.05$) increased from 88.85oC in sample A (100% wheat flour) to 89.65 - 93.70oC in the composite blends. The composite blends which have higher pasting temperature will take more time to gelatinize than 100% wheat flour. [40] also reported a gradual increase in pasting temperature for wheat flour substituted with germinated *Moringa* flour.

Physical Properties of Cake Baked with the Best Optimized Flour Blend

The physical properties of cake prepared from the best flour blend (run 1) and control are presented in Table 3. Batter density decreased from 0.89 g/cm^3 in the control to 0.88 g/cm^3 in run 1. The decrease was very minimal and it could be due to decreased air incorporation in batter due to reduced gluten content in the flour [45]. The decrease in batter density due to substitution of *Moringa* and African oil bean seed flours could be responsible for the reduction in cake volume as reported by [40] for wheat flour substituted with germinated *Moringa* flour. Cake volume of the control was 1375 cm3 while run 1 was 1306.25 cm3. [46] also reported that composite blends with high peak viscosity could result to high gas retention and high expansion of the product hence an increase in cake volume. Volume index of the control reduced from 19.5 to 18 in sample run 1. Reduced volume index was also reported by [40] for wheat flour substituted with germinated *Moringa* flour and it was attributed to reduced peak viscosity of the flour blends. [47] however reported that there are other factors that could influence final volume such as starch gelatinization, gas loss during processing and possible structure collapse after baking. A decrease in weight was observed in substitution of wheat flour with *Moringa* and African oil bean seed flours. While the control was 759.1g, sample run 1 was 744.4g. This could be attributed to reduction in bulk density [40] as a reduction in cake weight was also reported for wheat flour substituted with germinated *Moringa* flour.

Sample	Batter desity	Cake weight (g)	Cake volume (cm^3)	Volume index
Control	0.89 ± 0.00^a	759.10 ±0.20^a	1375.00 ± 0.12^a	19.50 ±0.10^a
Run 1	0.88 ± 0.01^{ab}	744.40 ± 0.10^b	1306.25 ± 0.10^b	18.00 ± 0.10^b

Table 3: Physical Properties of Cake Baked with the Optimum Blend and 100% Wheat Flour.

Run 1- Cake from 81.20 %Wheat/8.68 %Moringa seed/10.12 % African oil bean seed.

Control - Cake from 100 % wheat flour

Sensory Properties of Cake Baked with the Best Optimized Flour Blend

The result of sensory properties of cakes is shown in Figure 3. Pane lists rated cake prepared from the control (100% wheat flour) better in terms of crust colour, crumb colour, aroma, texture, taste and overall acceptability compared with run 1. The slight reduction in crust colour and crumb colour scores as a result of the addition of *Moringa* seed and African oil bean seed flours could be attributed to the peculiar colour of African oil bean seed. The reduced score in aroma of run 1 compared with the control could be attributed to high bioactive compounds in *Moringa* and African oil bean than wheat. This trend of result also reflected in the taste attribute of sample run 1. [40] reported similar trend in the result of aroma and taste for wheat-germinated *Moringa* blend and also recounted that aroma of food products is associated with the interaction of flavor compounds present when foods are subjected to high temperature. Cake sample from the control (100% wheat flour) was preferable in overall acceptability however, cake from the composite flour was not scored poorly either. The result showed that cake from 100% wheat flour was more preferred; this could be due to the perceivable aroma especially from African oil bean seed [48,49].

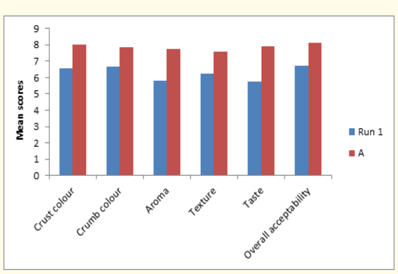

Figure 2: Sensory properties of best optimized blend and 100% wheat flour.

Run 1- Cake from 81.20%Wheat/8.68%Moringa seed/10.12% African oil bean seed

A- Cake from 100% wheat flour (Control)

Conclusion

Functional wheat based composite flour comprising *Moringa* seed and African oil bean seed was developed. The results of the proximate analysis showed composite flour with good nutritional and functional properties. The functional and pasting properties showed a good compliance to flour properties. The physical properties and sensory results showed that cake from the composite flour was not a bad idea. The use of optimal mixture model of response surface methodology helped in obtaining optimum flour combinations in terms of the quality characteristics, nutritional evaluations and pasting properties. Overall, run 1 (81.20%Wheat, 8.68%*Moringa* seed and 10.12% African oil bean seed flours) was the best in terms of all the properties considered followed by Run 15 (90%Wheat, 5%*Moringa* seed and 5%African oil bean seed flours).

Conflict of Interest

There is no conflict of interest whatsoever with regards to this work.

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