The Physical, Sensory And Staling Properties Of Wheat (Triticum Spp) -Walnut (Juglansregia) Cakes.

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Abstract: Cakes were produced from the composite flour blends of wheat (Triticum spp)/ walnut (Juglanregia) in the ratio of 100:0, 90:10, 80:20, 70:30, and 50:50 respectively. Analyses were carried out to determine consumers' acceptability and physical quality of the cake samples, as well as their staling properties during five days storage at ambient temperature. The composite cake with 90% wheat flour and 10% walnut flour had the highest general acceptability by the panelists during sensory evaluation. High percentage of walnut flour addition (50% wheat flour and 50% walnut flour) affected the appearance of the cake, giving it an unattractive dark appearance. Physical properties data indicated a decreasing level of height, weight and volume of the cakes (4.99cm – 3.93cm, 134.58g – 86.55g and 196.50cm3 – 127.01cm3) respectively, with increasing levels of walnut substitution in the cakes. Moisture content, weight loss, amylose, soluble starch, and specific volume of the cakes were monitored and were found to be significantly (p<0.05) affected when stored at ambient temperature for 5days, thereby inducing staling. Moisture, amylose and soluble starch of the cakes decreased each day during the storage studies; the specific volume of the cakes increased while the weight of the cakes reduced each day during the storage studies.

Keywords: Cake, physical, sensory, staling properties, wheat, walnut.

1 Introduction

Cakes are flour confections that are mostly prepared from wheat flour and other essential ingredients. The consumption of cakes prepared from wheat flour has become very popular in most developing countries of the tropics especially among children and adolescent [18]. Formulation and development of nutritious cakes product from local and readily available raw material have received a lot of attention in many developing countries due to malnutrition which has been known as a major problem especially to infants as a result of lack of several essential nutrients in the food product "[4], [29]".Walnut flour has a high amount of protein and essential fatty acid which has made it serve as a supplement or modifier for other food products. Several studies have been made on the combination of wheat flour with legume crops for the development of nutritious cakes. Published works on the properties of walnut flour made from the oil seed walnut has shown that it has several essential nutrients which can serve as a substitute to wheat flour in the production of nutritious cakes. Cake flour is finely milled white flour made from soft wheat. It has very low protein content between 8% and 10% making it suitable for soft texture cakes and cookies. The higher protein content of other flour would make the cake tough. Highly sifted cake flour may require different volume amounts in recipes than all-purpose flour [12].

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Baked products such as cake and bread undergo changes such as physical and chemical changes which are referred to as staling [6]. This is due to the loss in the quality of the baked product. The subject of staling is certainly not something new and studies on this particular topic go back many years. Various definitions have been given to the term "staling." Very broadly speaking, staling refers to all of the changes which occur in baked products after baking and has been defined as "a term which indicates decreasing consumer acceptance of bakery products by changes in the crumb other than those resulting from action of spoilage organisms."[14]. Several parameters are used in the determination of cake staling. A complex set of conditions determines bakery product shelf life, which complicates efforts to extend the "life" of these items. Extending their longevity relies on product developers, process technologists and packaging technologists to produce attractive and good-tasting products that don't harbor microorganisms. Some of the changes that occur in cakes as a result of staling include: Increase in crumb firmness: there is always a gradual increase in the firmness of the cake which is a factor that determines the staling of cake. The term firmness refers to the force necessary to obtain a given deformation [11]. Starch retrogradation: It is known that starch retrogradation implies hardening of the starch gel; therefore, it is responsible for the increased firmness of the stale product. Retrogradation is a reaction that takes place in gelatinized starch when the amylose and amylopectin chains realign themselves, causing the liquid to gel. When native starch is heated and dissolves in water, the crystalline structure of amylose and amylopectin molecules are lost and they hydrate to form a viscous solution. If the viscous solution is cooled or left at lower temperature for long enough period, the linear molecules, amylose, and linear parts of amylopectin molecules retrograde and rearrange themselves again to a more crystalline structure. Retrogradation can expel water from the polymer network. This is a process known as syneresis. Small amount of water can be seen on top of the gel. Retrogradation is directly related to the staling or aging of breads and cakes [13]. During staling, there is migration of moisture from the starch granules into the interstitial space which degelatinizes the starch. As the amylose and amylopectin molecules realigns, they cause recrystallization. This then results in the staling of cake giving it its hard and leathery texture. Flavor is usually lost in air while the unpleasant flavor is absorbed from it as well. This is known as retrogradation. Other changes include change in moisture content, specific volume and weight of the cake [14]. Understanding how to extend shelf life requires defining what determines loss of shelf life. "It's dry," "tastes stale" or "this is soggy" are familiar phrases, but how can they be translated into their underlying physical and chemical conditions? Some solutions are simple; others are complex. Certain deleterious chemical and physical changes are eventual and unavoidable. However, methods exist to delay them, providing a product with a few more days or weeks of high-quality life [16]. Shelf life and tolerance to staling determine the quality of industrial cakes "[9], [21]". After baking, all bakery products undergo a series of chemical and physical changes which are referred to as staling [6]. Staling results in loss of freshness and quality of the baked product. The gradual increase in the firmness of the baked cake product is the most important change associated with staling. A major problem facing developed countries like Nigeria today is malnutrition which has contributed to infant mortality, poor physical and intellectual development in infant and low resistance to diseases. Another problem is the cost in the importation of wheat. There is limited information on wheat/walnut cakes and their staling properties. Cake produced from walnut flour and wheat flour will help enhance its nutritional quality. The study will result in increase in the demand of the walnut crop and it will contribute to product diversity. The main objective of this study was to determine the effect of walnut flour substitution in wheat flour on the quality of the cake. The specific objectives were to produce composite flour samples from wheat/walnut flours at different level of substitution, to produce cakes with the flour samples, to determine the consumer acceptance and physical properties of the cake sample and to observe the staling properties of the cakes samples during storage at ambient temperature.

MATERIALS AND METHODS

Collection of Sample
Whole walnuts and Wheat flour were purchased from Ndioro market in Umuahia, Abia State, Nigeria. The walnuts were sent to the Botany department of Michael Okpara University of Agriculture, Umudike, Abia State for proper identification. The analyses were carried out in Food Science and Technology department of Michael Okpara University of Agriculture, Umudike and Optimal laboratory, Abiriba street, Umuahia. The reagents used for analyses were of analytical grades.

Plate 1: Unshelled walnut

Plate 2: Wheat flour

Preparation of Sample
The whole walnuts (Juglanregia) were first washed thoroughly to remove any adhering contaminants. They were then cooked in a steel pot for 30 minutes to remove the shells. The deshelled walnuts were then reduced into smaller sizes with the aid of stainless steel knife. They were then blanched in hot water for 5 minutes before draining. After blanching, the walnuts were dried in a hot air oven at 60oC for 5 hours to remove moisture. They were then milled and sieved to produce the walnut flour [17].

Plate 3: Unsieved walnut flour

Plate 4: Sieved walnut flour

Composite Flour Formulation
Different composite flour samples were prepared by combining 100%, 90%, 80%, 70%, 50%, wheat flour and 0%, 10%, 20%, 30%, and 50% walnut flour respectively (table 1). Wheat flour was coded with A and Walnut flour with B according to "[19].

Table 1: Showing blends of wheat flour (A) and walnut flour (B) used in composite flour formulation.

CODE	WHEAT FLOUR (%)	WALNUT FLOUR (%)
AB 1 (100% wheat flour)	100	0
AB 2 (90% wheat flour : 10% walnut flour)	90	10
AB 3 (80% wheat flour : 20% walnut flour)	80	20
AB 4 (70% wheat flour : 30% walnut flour)	70	30
AB 5 (50% wheat flour : 50% walnut flour)	50	50

The composite flour samples were then used to produce cakes and the sensory properties, physical properties and staling of the cakes were evaluated.

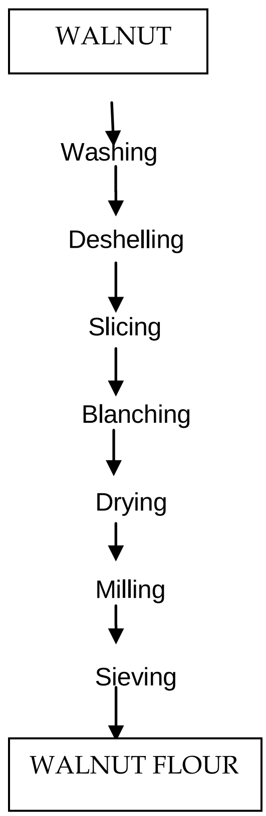

Fig1: Flow diagram on the production of walnut flour

Cake Making Process

All the five samples were baked into cakes using the creaming method according to “[7]. Three hundred grams of each flour sample were mixed together in a bowl until a uniform mixture of flour was achieved. Five grams of baking powder and ten grams of vanilla flavor were added to the flour mixture. Four medium size eggs, one hundred grams of granulated sugar, and two hundred grams of butter was mixed thoroughly to form a cream. The cream was then mixed with the flour thoroughly with thirty mils water until a slight firm mixture known as batter was achieved. Queen crown cake pans having the shape of a bucket were prepared by rubbing the insides with soft butter and also incorporating small quantity of flour in the greased pans. The cake batter was then poured in the greased pans. Due to the rising nature of the batter, it was not filled to the brim. Space was left on top of the pan. It was then put in an oven of 180oC for twenty minutes to bake.

Sensory Evaluation

The sensory attributes of the cakes were determined by twenty five member panelist. The attributes was based on appearance, texture, taste, aroma, and general acceptability. The 9 – point hedonic scale with a scale ranging from one to nine with one representing the least score (dislike extremely) and nine the highest score (like extremely) was used to collect data [31]. Analysis of variance (ANOVA) was used on the data collected to determine the difference. Least significant test according to “[18] was used to detect the differences among means.

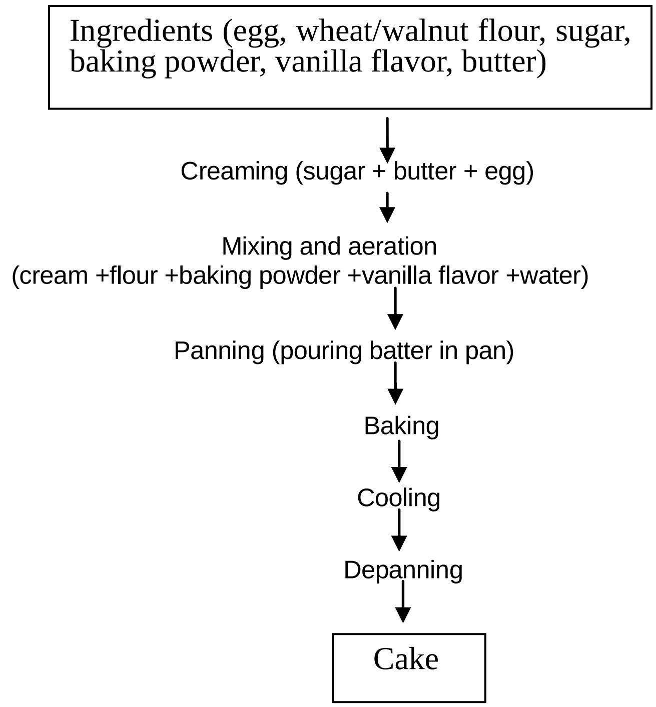

Fig 2: Flow diagram of the cake production

Physical Properties Determination

Weight and height of cakes were measured according to the methods as described by “[3]. Volume of cake was determined according to [16]. The weights of the cakes were measured using an electronic weighing balance. A graduated scale (in centimeters) was used to measure the height of cakes.

Volume of cake = $h \times 3.142 (R12 + R22 + R1 \times R2) / 3$
Where h = height of cake
$R1$ = radius of the top of cake
$R2$ = radius of the bottom of cake.

Storage Studies on the Staling Properties of the Cakes

To measure the staling properties of the cakes, moisture content, weight loss, amylose content, soluble starch and also specific volume were determined. All measurements were done each day during five days storage of the cakes at ambient temperature (21oC).

Amylose Content Determination

On each day of the storage of the cakes, the cake samples were analyzed on their amylose content using spectrophotometric method as described by “[23]. About 0.2g of the cake samples were washed inside a 250ml conical flask plus 8ml of 90% dimethyl sulfoxite (DMSO) and mixed vigorously for 2 minutes using a vortex mixer. The flask was heated in a water bath at 850C for 15 minutes and was allowed to cool at room temperature. The flask was made up to the mark with distilled water. 1ml of the stock solution was collected and transferred inside a 50ml volumetric flask plus 100ml distilled water. Five (5ml) of the iodine solution was also added and mixed vigorously and make up to 50ml with distilled water and it was allowed for color development for 15 minutes before taking absorbance at 600mm. Also a standard amylose was prepared using pure potato amylose.

$$\% \text{ amylose} = \frac{\text{Absorbance} - 0.2128}{0.0168}$$

Weight Loss

On each day of storage, the weight loss of the cake samples was determined. The weight of the cake batter before baking was determined and also the weight of the just baked cake after cooling for one hour was determined. Then each day of storage, the cake samples were also weighed [2].

Weight loss (%) after one hour of cooling

$$\frac{Wd - Wb}{Wd} \times 100$$

Weight loss (%) during storage

$$\frac{Wb - Wc}{Wb} \times 100$$

Where: Wd = weight of the cake batter (g)
Wb = weight of baked cake after cooling for one hour (g)
Wc = weight of cake sample per day during storage (g)

Soluble Starch Determination

This was determined using spectrophotometric method described by [2]. Two grams of the sample cakes were weighed inside a centrifuge tube. 10ml of 80% ethanol was added and the mixture was centrifuged at speed of 3000rpm. It was kept for soluble sugar analysis. 5ml of 1.1% HCL was added to the residue and heated in a water bath at 1000C for 30 minutes. The resulting mixture was distilled with distilled water. 1ml of the kept solution was pipette into 10ml test tube and cooled. Five (5ml) of the amylose reagent was added and heated for 10 minutes. The absorbance of the sample solution was taken at 630 wavelengths. A standard starch solution was prepared.

Specific Volume

The volume of the cake sample was first determined according to [16], then the volume of the cake was divided with its weight to determine the specific volume as shown in the equation below as described by [1].

Specific volume = volume (cm3) / weight (g)

Statistical Analysis

All experiments were conducted in triplicates and the mean values and standard deviations were reported. Analysis of variance (ANOVA) was performed and results were separated using the Multiple Ranges Duncan's test ($P < 0.05$) using statistical software of Statistical Package for the Social Sciences (SPSS), Version 16; (SPSS, Inc. New Jersey, USA).

RESULTS AND DISCUSSION

Table 1 presents the sensory scores of cakes made from the five flour samples. The appearance of baked product is a function of the properties of flour as well as the baking conditions and method. For appearance, samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour), AB3 (80% wheat flour and 20% walnut flour) and AB4 (70% wheat flour and 30% walnut flour) were not significantly different from each other at ($p > 0.05$). Samples AB3 (80% wheat flour and 20% walnut flour) and AB4 (70% wheat flour and 30% walnut flour) were not significantly different from sample AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$) but AB1 (100% wheat flour) and AB2 (90% wheat flour and 10% walnut flour), were significantly different from AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$). This showed that sample AB1 (100% wheat flour) and AB2 had the best appearance compared to AB5 (50% wheat flour and 50% walnut flour) meaning that the 10% substitution of walnut flour in AB2 (90% wheat flour and 10% walnut flour) was not really noticeable in terms of the cake appearance. However, AB5 (50% wheat flour and 50% walnut flour) have 50% walnut substitution had an adverse effect on the appearance of the cake which gave the cake unattractive dark brown appearance. For texture, samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour) and AB3 (80% wheat flour and 20% walnut flour) were not significantly different from each other at ($p > 0.05$), samples AB1 (100% wheat flour) and AB3 (80% wheat flour and 20% walnut flour) were not significantly different from sample AB4 at ($p > 0.05$), sample AB4 (70% wheat flour and 30% walnut flour) was not significantly different from AB5 (50% wheat flour and 50% walnut flour) at ($p > 0.05$), however, sample AB2 (90% wheat flour and 10% walnut flour) is significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour). This showed that sample AB2 (90% wheat flour and 10% walnut flour) had the best texture compared to AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour). For taste, samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour) and AB3 (80% wheat flour and 20% walnut flour) were not significantly different at ($p >0.05$), samples AB3 (80% wheat flour and 20% walnut flour), AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) were not significantly different from each other at ($p > 0.05$), but samples AB1 (100% wheat flour) and AB2 (90% wheat flour and 10% walnut flour) are significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$). This showed that AB1 (100% wheat flour) and AB2 (90% wheat flour and 10% walnut flour) had the best taste compared to samples AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour). This could be as a result of the absence or very little quantity of walnut flour substitution to the wheat flour which was not really noticeable in the taste during consumption of the cakes. High percentage of walnut flour substitution to wheat flour made the cakes had peppery taste which made the panelists to less prefer it. This indicated that the tastes of 100% wheat flour and 10% walnut substituted cakes were mostly preferred by the panelists. For the aroma, samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour) and AB3 (80% wheat flour and 20% walnut flour) were not significantly different from each other at ($p < 0.05$), samples AB2 (90% wheat flour and 10% walnut flour) and AB3 (80% wheat flour and 20% walnut flour) were not significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$), but sample AB1 (100% wheat flour), was significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$). This showed that the control cake (AB1) had the best aroma compared to AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) meaning that the addition of the walnut flour must have suppressed the flavor of the ingredients used in the dough making, changing the cakes aroma, which panelists less preferred. For general acceptability, sample AB1 (100% wheat flour) (7.76), AB2 (90% wheat flour and 10% walnut flour) (8.01) and AB3 (80% wheat flour and 20% walnut flour) (7.12) cakes were not significantly different from each other at ($p > 0.05$), sample AB3 (80% wheat flour and 20% walnut flour) and AB4 (70% wheat flour and 30% walnut flour) were not significantly different from each other at ($p > 0.05$) and sample AB4 (70% wheat flour and 30% walnut flour) did not significantly differ from AB5 (50% wheat flour and 50% walnut flour) at ($p > 0.05$). However, sample AB2 (90% wheat flour and 10% walnut flour) was significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) at ($p < 0.05$). This showed that AB2 (90% wheat flour and 10% walnut flour) was more acceptable than AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) ;the least accepted (6.76). Physical characteristics of the cakes, such as height, weight and volume, were affected by the increase in the level of walnut flour substitution as shown in table 2. Sample AB1 which was the control cake (100% wheat flour) had the greatest height of 4.99cm, highest weight of 134.58g and the highest volume of 196.50cm3 compared to the rest of the samples supplemented with walnut flour. This showed that the walnut supplemented in the cakes led to a reduction in the height, weight and volume of the cakes. The decrease in volume of the cakes could be due to increase in the replacement of wheat flour with walnut flour which weakened the gluten network of the dough which is responsible for retaining the leavening gases that help in the rising of the cakes. It must be noted that sample AB5 (50% wheat flour and 50% walnut flour) had the highest protein content in its flour (21.57%), but it did not produce the cake with highest volume. This confirmed the fact that flour performance on bread and cake making does not only depend on the quantity of protein but quality. Similarly, "[24] reported reduction in loaf volume as a result of dilution of wheat gluten by cowpea protein. During the storage studies, the cake samples were stored in transparent plastic containers at ambient temperature and were analyzed for moisture content, weight loss, amylose content, soluble starch content and specific volume for 5 days. Table 3 shows the significant differences of moisture content between the cake samples during five days storage at ($p < 0.05$). The cake samples showed a decrease in crumb moisture content during 5 days of storage. In the cause of storage, the moisture migrates from the crumb toward the crust and evaporates from the surface of the product [26]. On the first day of storage, the moisture content of the five cake samples significantly reduced and were different from each other at ($p < 0.05$). Sample AB1 (100% wheat flour) which is the control cake had the highest moisture content of 32.51%, closely followed by sample AB5(50% wheat flour and 50% walnut flour) with moisture content of 31.80%. Sample AB4 (70% wheat flour and 30% walnut flour) had the least moisture (29.79%). On the second day, there was also a significant difference at ($p < 0.05$) amongst the cake samples. On the third day, samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) were not significantly different from each other at ($p < 0.05$), but AB5 was significantly different from AB4 (70% wheat flour and 30% walnut flour) and AB3(80% wheat flour and 20% walnut flour). This could be as a result of the massive increment in the moisture content of AB5 (50% wheat flour and 50% walnut flour) which it gained from the atmosphere. On the fourth and fifth days, there was also significance difference between the cakes samples. This showed that the rate of moisture loss was within range as shown in table 4. Loss of moisture from the crumb of bread and cakes leads to firmness and these results to staling. This also shows that the rate of firming of cakes has an inverse relationship to crumb moisture content [27]. This is also in line with the findings of [28]. Tables 5 and 6 showed the effect of storage on the quantity and composition of soluble starch and amylose content of the cake samples during five days storage at ambient temperature. The result showed the significant differences of soluble starch and amylose content among the cake samples during the five days of storage at ($p < 0.05$). From day one to five, the five samples showed sharp significant differences amongst them at ($p < 0.05$) as shown in table 5 and 6. This showed that the cake samples contained varying amount of amyloses and soluble starches. There was a gradual decrease in the soluble starch and amylose of the cake samples maintaining its range of reduction in each day of storage. Sample AB1 (cake from 100% wheat flour) had the highest percentage of soluble starch and amylose. The values reduced as wanut flour substitution increased. Soluble starch of sample AB1 (100% wheat flour) reduced from 0.79% to 0.53% and amylose reduced from 0.38% to 0.13% during the five days of storage, sample AB2(90% wheat flour and 10% walnut flour) soluble starch reduced from 0.72% to 0.42% and amylose reduced from 0.33% to 0.19% during the five days of storage, sample AB3 (80% wheat flour and 20% walnut flour) soluble starch reduced from 0.60% to 0.39% and amylose reduced from 0.22% to 0.09% during the five days of storage. Sample AB4 (70% wheat flour and 30% walnut flour) soluble starch reduced from 0.56% to 0.28% and amylose reduced from 0.18% to 0.07% during the five days of storage, sample AB5 (50% wheat flour and 50% walnut flour) which had the least percentage of soluble starch and amylose on the first day compared to other samples reduced in its soluble starch from 0.52% to 0.22% and amylose from 0.13% to 0.05% during the five days of storage. Soluble starch and amylose were released to the environment during de-gelatinization process of the starch and the amount of soluble starch and amylose decreases with the staling process because they tend to reassociate during retrogradation [32]. Therefore, the amount of soluble starch and amylose is used as an indicator of staling. From this discussion, it could be seen that the walnut flour had no impact in the staling rate of the cakes as compared to the control (AB1) in terms of its losses on amylose and soluble starch. The decrease in soluble starch could possibly be due to starch molecules in pastes or gels which are known to associate on ageing, resulting in crystallite formation. Crystallites begin to form eventually, and this is accompanied by gradual increase in rigidity and phase separation between polymer and solvent (syneresis) [8]. Table 6 showed the specific volume of the cake samples at ($p < 0.05$) during five days storage. There were sharp significant differences between AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour), AB3 (80% wheat flour and 20% walnut flour), AB4 (70% wheat flour and 30% walnut flour) and AB5 (50% wheat flour and 50% walnut flour) in terms specific volume during the five days storage. This was because sample AB3 (80% wheat flour and 20% walnut flour) had the highest specific volume of 2.05cm3, closely followed by sample AB4 (70% wheat flour and 30% walnut flour) which had specific volume of 1.68cm3. AB2 (90% wheat flour and 10% walnut flour) has the least specific of 1.41cm3. Samples AB1 (100% wheat flour), AB2 (90% wheat flour and 10% walnut flour) and

AB3 (80% wheat flour and 20% walnut flour) increased gradually in their specific volume in each day of storage maintaining their range of increment, however, sample AB4 (70% wheat flour and 30% walnut flour) reduced in specific volume on the second day but increased from the third day till the fifth day. Sample AB5 (50% wheat flour and 50% walnut flour) increased in specific volume on the first day to the fourth day but reduced on the fifth day. The changes in specific volumes of the cake samples were affected by decrease in the weight of the cakes in each day of storage and also changes in the volume of the cakes based on the measurement of height and radius of the top and bottom of the cakes. Figure 3 showed the percentage weight loss of the five cake samples after one hour of cooling immediately after baking (day 0) and during five days of storage. Each sample was represented with a key on the graph. As could be seen in the figure, there were significant differences at ($p < 0.05$) in weight loss among the cake samples during one hour of cooling after baking (day 0). Sample AB1 (100% wheat flour) which was the control cake had the least weight loss of 4.33% after an hour of cooling as compared to other samples supplemented with walnut flour at different level of substitution. This reflected the water binding capacity of the starch in wheat flour. Interior heating during baking resulted in internal pressure which resulted in the loss of moisture from the baked product that led to weight loss [10]. All the cake samples lost weight each day of storage. On the fifth day of storage, sample AB1 (100% wheat flour) had the least percentage weight loss of 9.44% compared to other supplemented samples. This showed that cake samples supplemented with walnut flour lost more weight as a result of increased moisture loss, due to their low water binding capacity and also due to loss of other contents such as amylose and amylopectin and other volatiles. From this result, it could be seen that cakes supplemented with walnut flour lost more moisture and several compounds which led to their massive weight loss. These invariably could result in higher staling rate than cakes from 100% wheat flour.

CONCLUSION

It has also been shown from this study that cakes from composite flour of 30% walnut flour substitution to wheat flour were generally accepted by the sensory panelists. This means that a nutritionally balanced and organoleptically acceptable cake which would have little or no effect on the price of the product could be obtained by partially incorporating walnut flour into wheat flour. This study on staling showed that process and mechanism of staling differs between cakes from wheat flour (100%) and composite flour (wheat/walnut blends). Cakes from the supplemented wheat flour tend to stale faster than those from wheat flour(100%) due to its high rate of weight loss which resulted from higher loss in moisture, soluble starch, amylose, and other volatile compounds from the composite cake. More studies need to be conducted on ways to extend the shelflife of cakes made from the composite flours (wheat/walnut flour).

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Table 1: Sensory scores of cakes made from composite flour samples of wheat flour and walnut flour blends at ($p < 0.05$).

CODE	APPEARANCE	TEXTURE	TASTE	AROMA	ACCEPTABILITY
AB1	8.08a	7.68ab	7.60a	7.64a	7.76ab
AB2	7.92a	7.96a	7.88a	7.24ab	8.04a
AB3	7.52ab	7.36ab	7.08ab	6.76ab	7.12ab
AB4	7.44ab	7.16bc	6.60b	6.40b	7.12bc
AB5	6.80b	6.68c	6.36b	6.36b	6.76c

Values are means ± standard deviation of triplicate determination

Means with different superscript in the same column are significantly different at $P < 0.05$.
AB1 (100% wheat flour)
AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)
AB4 (70% wheat flour and 30% walnut flour)
AB5 (50% wheat flour and 50% walnut flour)

Table 2: Physical attributes of the cake samples.

SAMPLE CODE	HEIGHT	WEIGHT	VOLUME
AB1	4.99a ± 0.02	134.58a ± 0.02	196.49a ± 0.01
AB2	3.93e ± 0.06	97.61b ± 0.02	137.65c ± 0.01
AB3	4.49b ± 0.01	88.26c ± 0.02	180.96b ± 0.01
AB4	4.20d ± 0.00	75.60e ± 0.00	127.01e ± 0.01
AB5	4.20c ± 0.00	86.55d ± 0.00	132.42d ± 0.01

Values are means ± standard deviation of triplicate determination
Means with different superscript in the same column are significantly different at $P < 0.05$.
AB1 (100% wheat flour)
AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)

AB4 (70% wheat flour and 30% walnut flour)
AB5(50%wheat flour and 50% walnut flour)

Table 3: Moisture content of the wheat/walnut cake samples during five days of ambient temperature storage.

SAMPLE CODE	Storage Period (days)				
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
Moisture (%)					
AB1	32.51a ± 0.08	31.62a ± 0.03	28.75ab ±0.01	27.20d ± 0.04	26.18c ± 0.02
AB2	31.71c ± 0.03	30.25c ± 0.02	29.34ab ±0.05	28.50b ± 0.08	26.52b ± 0.07
AB3	30.67d ± 0.02	29.84d ± 0.05	27.50b ± 0.08	26.30e ± 0.02	24.31e ± 0.01
AB4	29.79e ± 0.02	28.70e ± 0.04	27.40b ±0.04	27.51c ±0.08	25.45d ± 0.02
AB5	31.80b ± 0.02	30.80b ± 0.02	32.98a ± 5.80	28.80a ± 0.02	27.67a ± 0.14

Values are means ± standard deviation of triplicate determination
Means with different superscript in the same column are significantly different at ($P < 0.05$).
AB1 (100% wheat flour)
AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)
AB4 (70% wheat flour and 30% walnut flour)
AB5 (50% wheat flour and 50% walnut flour)

Table 4: Soluble starch content of the wheat/walnut cake samples during five days storage at ambient temperature.

SAMPLE CODE	Storage Period (days)				
Soluble Starch (%)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
AB1	0.79a ± 0.01	0.68a ± 0.01	0.65a ± 0.00	0.61a ± 0.01	0.53a ± 0.01
AB2	0.72b ± 0.00	0.58b ± 0.00	0.52b ± 0.01	0.48b ± 0.01	0.42b ± 0.01
AB3	0.60c ± 0.00	0.52c ± 0.01	0.49c ± 0.01	0.45c ± 0.00	0.39c ± 0.01
AB4	0.56d ± 0.06	0.48d ± 0.01	0.42d ± 0.01	0.42d ± 0.00	0.28d ± 0.01
AB5	0.52e ± 0.00	0.45e ± 0.00	0.51e ± 0.08	0.37e ± 0.08	0.22e ± 0.11

Values are means ± standard deviation of triplicate determination
Means with different superscript in the same column are significantly different at $P < 0.05$.
AB1 (100% wheat flour)
AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)
AB4 (70% wheat flour and 30% walnut flour)
AB5 (50% wheat flour and 50% walnut flour)

Table 5: Amylose content of the wheat/walnut cake samples during five days storage at ambient temperature.

SAMPLE CODE	Storage Period (days)				
Amylose Content (%)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
AB1	0.38a ± 0.01	0.33a ± 0.01	0.22a ± 0.01	0.18a ± 0.00	0.13a ± 0.02
AB2	0.35b ± 0.00	0.29b± 0.01	0.18b ± 0.01	0.15b ± 0.01	0.11ab ± 0.01
AB3	0.33c ± 0.01	0.25c ± 0.00	0.16c ± 0.01	0.13c ± 0.01	0.09b ± 0.01
AB4	0.29d ± 0.01	0.20d ± 0.01	0.14d ± 0.01	0.09d ± 0.01	0.06c ± 0.01
AB5	0.28e ± 0.01	0.19d± 0.01	0.09e ± 0.04	0.07e ± 0.01	0.05c ± 0.03

Values are means ± standard deviation of triplicate determination
Means with different superscript in the same column are significantly different at $P < 0.05$.
AB1 (100% wheat flour)

AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)
AB4 (70% wheat flour and 30% walnut flour)
AB5 (50% wheat flour and 50% walnut flour)

Table 6: Specific volume of the wheat/walnut cake samples during five days storage at ambient temperature.

SAMPLE CODE	Storage Period (days)				
Specific Volume (cm3/g)	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
AB1	1.46d ± 0.01	1.51d ± 0.02	1.52d ± 0.00	1.55d ± 0.01	1.56d ± 0.00
AB2	1.41e ± 0.01	1.44e ± 0.01	1.45e ± 0.00	1.48e ± 0.00	1.50e ± 0.02
AB3	2.05a ± 0.01	2.07a ± 0.01	2.09a ± 0.01	2.14a ± 0.02	2.19a ± 0.00
AB4	1.68b ± 0.01	1.54c ± 0.00	1.58c ± 0.00	1.66c ± 0.03	1.67c ± 0.01
AB5	1.53c ± 0.01	1.70b ± 0.02	1.73b ± 0.02	1.77b ± 0.02	1.73b ± 0.02

Values are means ± standard deviation of triplicate determination
Means with different superscript in the same column are significantly different at $P < 0.05$.
AB1 (100% wheat flour)
AB2 (90% wheat flour and 10% walnut flour)
AB3 (80% wheat flour and 20% walnut flour)
AB4 (70% wheat flour and 30% walnut flour)
AB5 (50% wheat flour and 50% walnut flour)

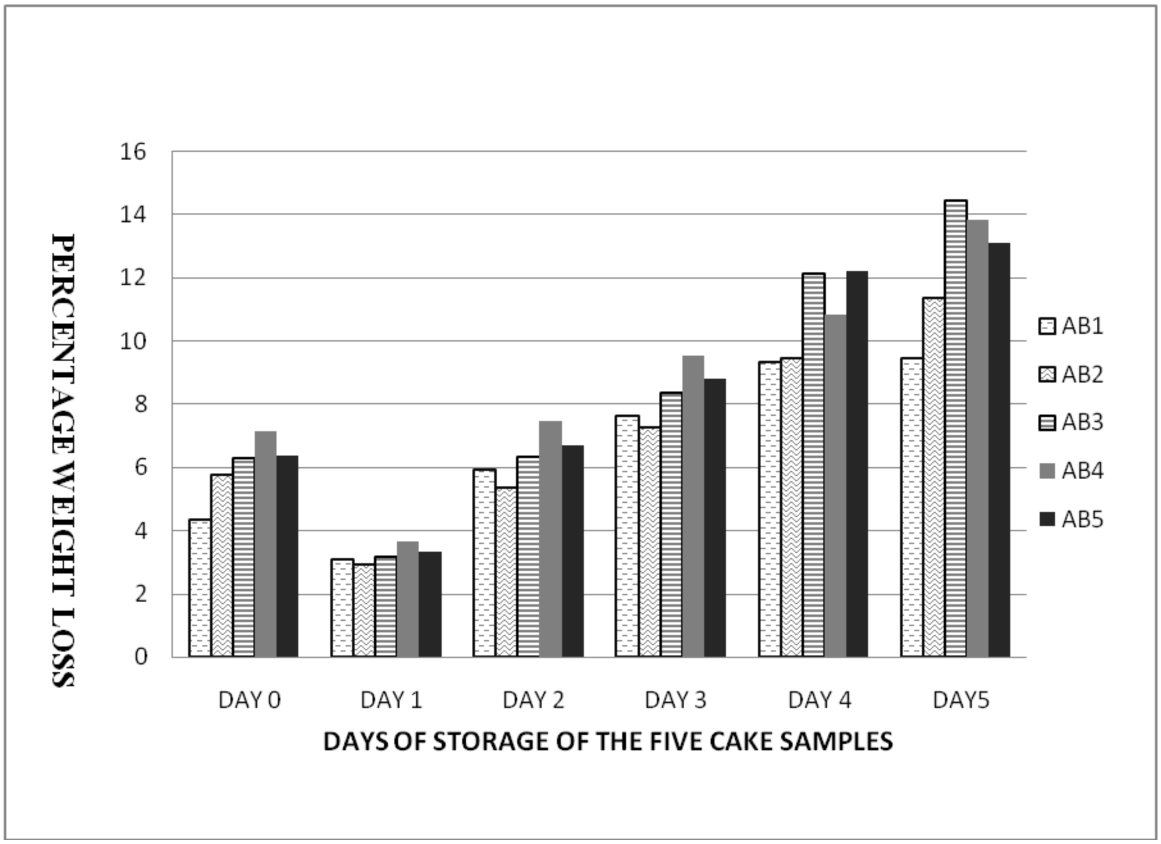

Figure 3: Showing graphical illustration of pecentage weight loss of the five cake samples during the five days of storage on a multiple bar chart.

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As demonstrated in this document, the numbering for sections upper case Arabic numerals, then upper case Arabic numerals, separated by periods. Initial paragraphs after the section title are not indented. Only the initial, introductory paragraph has a drop cap.

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$$\int_0^{r_2} F(r,\varphi)\, dr\, d\varphi = [\sigma r_2 / (2\mu_0)] \cdot \int_0^{\infty} \exp(-\lambda\, |z_j - z_i|)\, \lambda^{-1} J_1(\lambda r_2)\, J_0(\lambda r_i)\, d\lambda . \quad (1)$$

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols (T might refer to temperature, but T is the unit tesla). Per IJSTR, please refer to "(1)," not "Eq. (1)" or "equation (1)," except at the beginning of a sentence: "Equation (1) shows ... ." Also see The Handbook of Writing for the Mathematical Sciences, 1993. Published by the Society for Industrial and Applied Mathematics, this handbook provides some helpful information about math typography and other stylistic matters. For further information about typesetting mathematical equations, please visit the IJSTR styel guide: http://www.ijstr.org. Please note that math equations might need to be reformatted from the original submission for page layout reasons. This includes the possibility that some in-line equations will be made display equations to create better flow in a paragraph. If display equations do not fit in the two-column format, they will also be reformatted. Authors are strongly encouraged to ensure that equations fit in the given column width.

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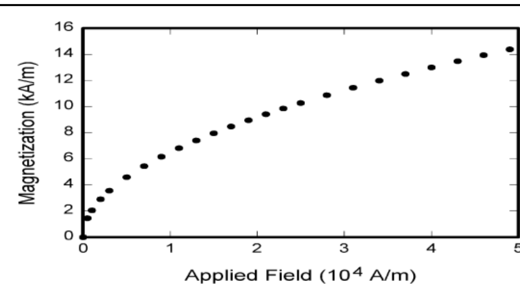

Fig. 1. Magnetization as a function of applied field. Note that "Fig." is abbreviated. There is a period after the figure number, followed by one space. It is good practice to briefly explain the significance of the figure in the caption.

Figure axis labels are often a source of confusion.
Use words rather than symbols. As an example, write the quantity "Magnetization," or "Magnetization M," not just "M." Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write "Magnetization (A/m)" or

"Magnetization ($A \cdot m^{-1}$)," not just "A/m." Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)," not "Temperature/K." Table 1 shows some examples of units of measure. Multipliers can be especially confusing. Write "Magnetization (kA/m)" or "Magnetization (103 A/m)." Do not write "Magnetization (A/m) × 1,000" because the reader would not know whether the top axis label in Fig. 1 meant 16,000 A/m or 0.016 A/m. Figure labels should be legible, approximately 8 to 12 point type. When creating your graphics, especially in complex graphs and charts, please ensure that line weights are thick enough that when reproduced at print size, they will still be legible. We suggest at least 1 point.

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Number footnotes separately in superscripts (Insert | Footnote)[1]. Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table 1). Please do not include footnotes in the abstract and avoid using a footnote in the first column of the article. This will cause it to appear of the affiliation box, making the layout look confusing.

TABLE 1

UNITS FOR MAGENTIC PROPERTIES

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI [a]
Φ	magnetic flux	$1\ Mx \rightarrow 10^{-8}\ Wb = 10^{-8}\ V \cdot s$
B	magnetic flux density, magnetic induction	$1\ G \rightarrow 10^{-4}\ T = 10^{-4}\ Wb/m^2$
H	magnetic field strength	$1\ Oe \rightarrow 10^3/(4\pi)\ A/m$
m	magnetic moment	$1\ erg/G = 1\ emu \rightarrow 10^{-3}\ A \cdot m^2 = 10^{-3}\ J/T$
M	magnetization	$1\ erg/(G \cdot cm^3) = 1\ emu/cm^3 \rightarrow 10^3\ A/m$
$4\pi M$	magnetization	$1\ G \rightarrow 10^3/(4\pi)\ A/m$
σ	specific magnetization	$1\ erg/(G \cdot g) = 1\ emu/g \rightarrow 1\ A \cdot m^2/kg$
j	magnetic dipole moment	$1\ erg/G = 1\ emu \rightarrow 4\pi \times 10^{-10}\ Wb \cdot m$
J	magnetic polarization	$1\ erg/(G \cdot cm^3) = 1\ emu/cm^3 \rightarrow 4\pi \times 10^{-4}\ T$
χ, κ	susceptibility	$1 \rightarrow 4\pi$
χ_ρ	mass susceptibility	$1\ cm^3/g \rightarrow 4\pi \times 10^{-3}\ m^3/kg$
μ	permeability	$1 \rightarrow 4\pi \times 10^{-7}\ H/m = 4\pi \times 10^{-7}\ Wb/(A \cdot m)$
μ_r	relative permeability	$\mu \rightarrow \mu_r$
w, W	energy density	$1\ erg/cm^3 \rightarrow 10^{-1}\ J/m^3$
N, D	demagnetizing factor	$1 \rightarrow 1/(4\pi)$

Statements that serve as captions for the entire table do not need footnote letters.

[a]Gaussian units are the same as cgs emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

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3. Items will be numbered, followed by a period.

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Theorems and related structures, such as axioms corollaries, and lemmas, are formatted using a hanging indent paragraph. They begin with a title and are followed by the text, in italics.

Theorem 1. Theorems, corollaries, lemmas, and related structures follow this format. They do not need to be numbered, but are generally numbered sequentially. Proofs are formatted using the same hanging indent format. However, they are not italicized.

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7 END SECTIONS

7.1 Appendices

Appendixes, if needed, appear before the acknowledgment. In the event multiple appendices are required, they will be labeled "Appendix A," "Appendix B, " etc. If an article does not meet submission length requirements, authors are strongly encouraged to make their appendices supplemental material. IJSTR Transactions accepts supplemental materials for review with regular paper submissions. These materials may be published on our Digital Library with the electronic version of the paper and are available for free to Digital Library visitors. Please see our guidelines below for file specifications and information. Any submitted materials that do not follow these specifications will not be accepted. All materials must follow US copyright guidelines and may not include material previously copyrighted by another author, organization or company. More information can be found at http://www.ijstr.org.

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Acknowledgment

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