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Influence of Red Kidney Bean and Defatted Coconut Flour Substitution on the Nutritional and Physical Quality of Bread

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Abstract

Aim: This study investigated the effect of substituting red kidney bean (RKB) and defatted coconut flour (CF) blends on the quality attributes of bread.

Methodology: Flours were produced from whole wheat (WW), RKB, and CF, and used to formulate six bread samples: S1 (100% refined wheat), S2 (100% WW), S3 (90% WW, 5% RKB, 5% CF), S4 (85% WW, 10% RKB, 5% CF), S5 (80% WW, 15% RKB, 5% CF), and S6 (75% WW, 20% RKB, 5% CF). The breads were evaluated for physical characteristics, proximate composition, mineral, and vitamin content.

Results: Loaf weight increased significantly ($p < 0.05$) from 190.23 g (S1) to 206.20 g (S6), whereas loaf volume, specific volume, and oven spring decreased significantly. Moisture, ash, fiber, fat, and protein contents increased significantly with increasing RKB-CF substitution, while carbohydrate content declined. Mineral contents (K, Na, Mg, P, Fe) and vitamin levels (B1, B2, B3, E) also increased significantly, with the highest values observed in S6.

Conclusion: Partial substitution of wheat flour with red kidney bean and defatted coconut flour significantly enhances the nutritional profile of bread, particularly in terms of dietary fiber, protein, minerals, and vitamins. However, this improvement is accompanied by a reduction in certain physical quality parameters.

Key word: Flour, wheat, defatted, substitution, and bread

Introduction

Bread is an important staple food in both developed and developing countries. Wheat (Triticum aestivum) flour of both hard and soft wheat classes has been the major ingredients of leavened bread for many years because of its functional proteins (Mesta-Corral et al., 2024). Many efforts have been carried out to promote the use of composite flour, in which a portion of wheat flour is replaced by locally grown crops, to be used in bread, thereby decreasing the cost associated with important wheat (Moawad et al., 2019).

Red kidney bean is a gluten-free legume that contains a high amount of fiber, high biological-value proteins, essential fatty acids (ω-3 and ω-6), vitamins, and minerals (Nwagbaoso et al., 2018). Red kidney bean can also be used in the bakery industry because the starch present in the seeds has properties similar to those found in wheat. On the other hand, the addition of coconut flour has shown positive effects on the sensory characteristics of bakery products such as bread (Adelekan & Alamu, 2021). Nutritionally, red kidney bean (legume) is a super seed and the World Health Organization has rated red kidney beans as equivalent to milk as it contains high levels of potassium, riboflavin, B6, niacin and thiamin along with magnesium, zinc, copper and manganese (Kambabazi et al., 2021). Therefore, red kidney bean alone or fortified with other gluten free flour can represent a healthy alternative for people with celiac disease (CD), Gluten-free breads is principally based on flour from rice or maize with low content and poor-quality proteins (Bhaduri., 2013).

Therefore, the objective of this study has been performed to evaluate the effect of substitution of wheat flour with different levels of red kidney beans and coconut flour on the physical and quality criteria of bread.

2. Materials and methods

2.1 Materials Procurement

Whole wheat grains and coconut fruits were sourced from a local market Makurdi metropolis of Benue state Nigeria while red kidney bean was sourced from Ndop main market, North West region Cameroon.

2.2 Preparation of Materials

Whole wheat, red kidney bean and defatted coconut flours were prepared following the method outlined by (Forwoukeh et al., 2023). Brief summary is presented Figure 1, 2 and 3 respectively

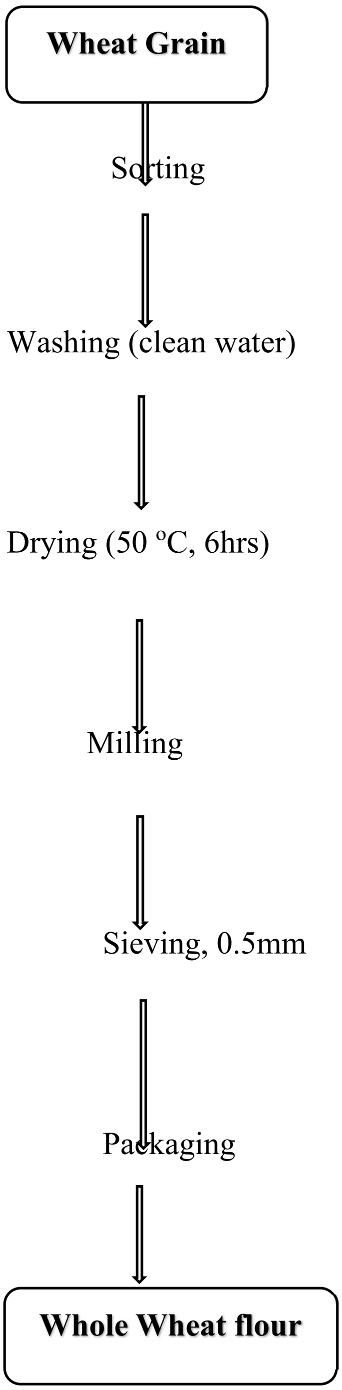

Figure 1: Processing whole wheat flour
Source: Forwoukeh et al. (2023)

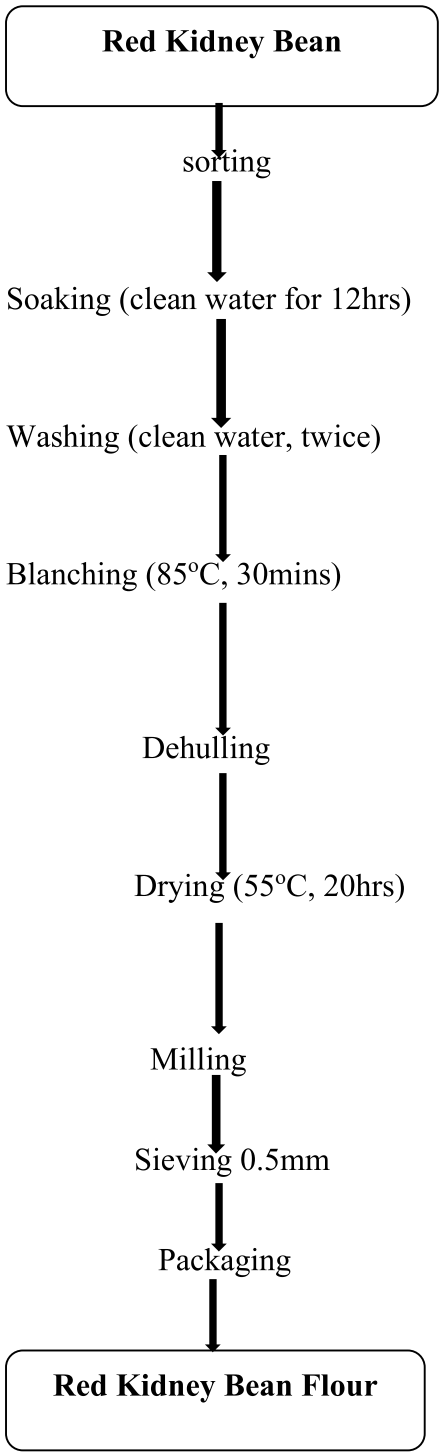

Figure 2: Processing red kidney bean flour
Source: Forwoukeh et al. (2023)

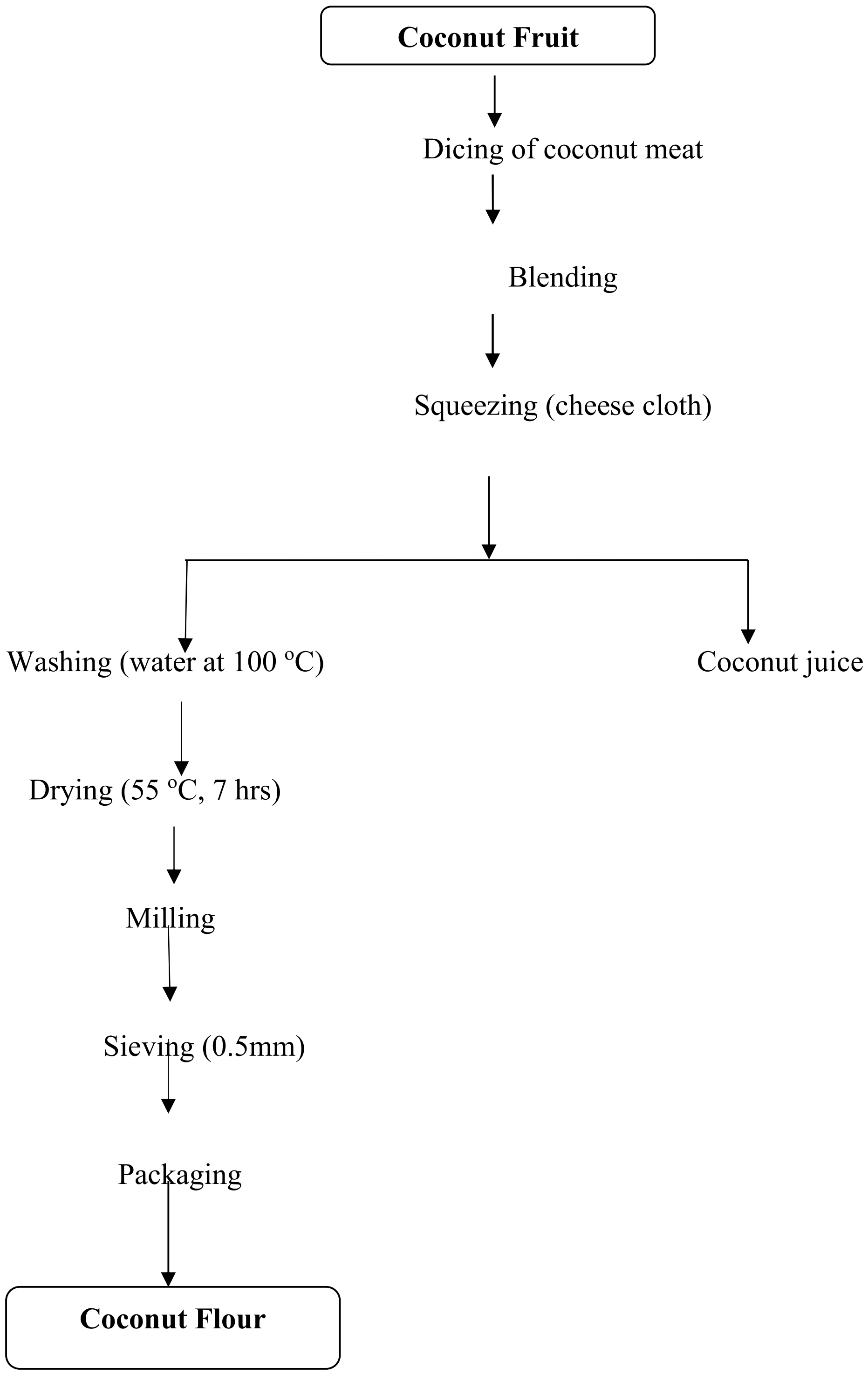

Figure 3: processing of defatted coconut flours
Source: Forwoukeh et al. (2023)

2.3 Product formulation

The product formulation is outlined in Table 1

Table 1: Formulation of flour blends for the preparation of bread

Samples	Refined Wheat flour	whole wheat flour	Red kidney bean flour	coconut flour
S1 control 1	100	0	0	0
S2 control 2	0	100	0	0
S3	0	90	5	5
S4	0	85	10	5
S5	0	80	15	5
S6	0	75	20	5

2.4 Bread processing

The method used for the preparation of bread samples was the straight - dough method as described by Adelekan and Alamu (2021). "All the ingredients were weighed and poured into a mixing bowl of the mixing machine. The ingredients were mixed with the aid of a mixer using slow speed for 5 minutes. Little water was added as the mixing continued, using high speed for 15 minutes. The dough was then put on a moulding table and moulded into desired shape (by hand). After cutting and weighing, the moulded dough was placed inside a lubricated baking pan and covered with a lubricated lid. It was transferred into a proofing chamber for 1hour 30 minutes in order to enhance fermentation and dough development, it was then transferred into the oven at temperature 200-2100C for 25 minutes". The bread was removed from the oven and cooled.

2.5 Physical Properties of Bread

Oven spring determination

The differences in the height of dough just before and after baking was used to determine the oven spring of the bread as described by Adeyeye et al. (2019).

Loaf volume determination

Sorghum seed displacement method was used to determine loaf volume according to the method described by Adeyeye et al. (2019); Peluola-Adeyemi et al. (2019). An empty container was used for the test, sorghum seeds were poured into an empty container until full and the sorghum seeds were measured in a graduated cylinder and marked as V_1. Each sample of bread was placed same empty container and sorghum seeds were poured till the bread sample was covered and the container was full. The sorghum seeds were collected and measured in a graduated cylinder as V_2. The volume of bread sample was determined by using the formula.

Loaf volume (ml) = $V_1 – V_2$

Weight of Bread

The weights of the loaves were obtained by using Adeyeye et al. (2019) method. Loaf samples were placed on the weighing balance that have previous zero and the weight values were recorded for each sample.

Specific volume: specific volume was obtained as a ratio of the volume of the bread to the weight of the bread. Volume (Okafor et al., 2012).

$$\text{specific Volume} = \frac{\text{loaf volume}}{\text{loaf weight}}$$

2.6 Proximate Composition of Bread

The proximate composition (moisture, crude protein, fat, ash, and crude fibre) of the bread samples were determined by using standard method, (AOAC, 2000) Carbohydrate content of bread samples was calculated by difference.

Determination of Mineral elements of bread samples

Sodium and Potassium were determined by Flame Photometry method. Calcium and Magnesium were determined by Versenate Titration Method. Phosphorous concentration in the sample was measured colourimetrically using the molybdovanadate method recommended by Iron concentration in sample digest was determined using Orthophenathroline colometric Method (Abuengmoh et al., 2022).

Determination of vitamin content of bread samples

Vitamins B_1, B_2, B_3 and vitamin E were determined through the spectrophotometric method, as described by Abuengmoh et al. (2022).

2.4 Data Analysis

Data obtained were analysed using the one-way ANOVA and mean separated using Duncan's Multiple Range Test (DMRT) at 5% limit of significant using Statistical package for social science (SPSS) version 26.

3. Results and discussion:

3.1 Physical properties of bread samples

The physical properties of the bread samples are presented in Table 2

Table 2: Physical properties of bread samples

Bread Samples	Loaf weight (g)	Loaf volume (cm^3)	Specific volume (cm^3/g)
S1	$190.23^{c}\pm4.44$	$612.50^{a}\pm2.50$	$3.21^{a}\pm0.07$
S2	$200.08^{b}\pm0.10$	$565.00^{b}\pm15.00$	$2.82^{b}\pm0.08$
S3	$203.97^{a}\pm0.04$	$545.00^{b}\pm15.00$	$2.67^{bc}\pm0.08$
S4	$204.13^{a}\pm1.63$	$495.00^{c}\pm35.00$	$2.42^{c}\pm0.19$
S5	$204.38^{a}\pm2.04$	$487.33^{c}\pm42.50$	$2.38^{c}\pm0.21$
S6	$206.20^{a}\pm1.02$	$372.50^{d}\pm27.50$	$1.57^{d}\pm0.43$

Key: Values are means of triplicate determinations ± S.D. Means followed by different superscript letters in the same column indicate significant difference at ($p<0.05$). **S1=** 100% refined wheat flour control 1, **S2=** 100% whole wheat flour control 2, **S3=** 90% whole wheat, 5% red kidney bean and 5% coconut flour blend, **S4=** 85% whole wheat, 10% red kidney bean and 5% coconut flour blend**,** **S5=** 80% whole wheat, 15% red kidney bean and 5% coconut flour blend, **S6=** 75% whole wheat, 20% red kidney bean and 5% coconut flour blend.

Loaf Weight of Bread Samples

The weight of the bread samples increases with increase in red kidney bean substitution. There was a significant difference ($p<0.05$) between the composite blends and the control samples (S1and S2). This could be because red kidney bean has more weight than whole wheat flour. This could however lead to poor carbon dioxide production and entrapment due to dilution in the gluten content (Ukeyima et al., 2019). This results are similar to those obtained by Ukeyima et al. (2019); Manonmani et al. (2014), In their separate works there concluded that the addition of non- wheat flour to wheat flour increased the loaf weight. As proposed by Eke et al. (2013) bulk bread is desirable to hungry consumers because it is stomach filling and satisfying.

Loaf Volume of bread samples

The loaf volume of the bread samples was observed to significantly ($p<0.05$) decrease with increase in the level of substitution with non- wheat flour, with S1 having the highest and S6 with the least value. Also the volume was seen to significantly ($p<0.05$) decrease from refined wheat flour (control 1) to whole wheat flour (control S2). The deleterious effect of addition of fiber and non- wheat flour on loaf volume has been suggested to be due to the dilution of gluten network, which in turn impairs gas retention rather than gas production. The gluten content of flour enables it to trap the gas produced during fermentation, yielding higher loaf volumes (Ndife et al., 2011). The result obtained is in line with the reports by Oloyede et al. (2013); Ndife et al. (2011); Agu et al. (2010); Okafor et al. (2012); Ocheme et al. (2010), who in their separate findings reported addition of non- wheat flour to all purpose flour reduce the volume of the bread loaf due to dilution of gluten protein in wheat flour. They also reported the addition of fiber to wheat flour reduce bread volume due to the disruption of gluten network by fiber. The decrease in bread volume is not economical favourable since bread is sold and bought in volume.

Specific volume of bread samples

The specific volume of the bread samples significantly ($p<0.05$) decrease from S1 to S6 with addition of red kidney bean and coconut flour. There are several explanations which may be relevant to the reduction of loaf specific volume. First, it is possible that physical disruption of gluten network by red kidney bean and coconut flour particles occur. Through observation on bread microstructure using scanning electron microscopy, (Manonmani et al., 2014) found that protein bodies and starch granules of red kidney beans disrupted the gluten network when the bean flour was added to dough. Second, it is also possible that the gluten in the samples were not sufficiently hydrated. Addition of dietary fibre has been found to reduce loaf specific volume due to competition between gluten and fibre for hydration (Okafor et al., 2012). This is in agreement with the report of (Okafor et al., 2012; Ukeyima et al., 2019; Ndife et al., 2011), they observed that addition of non-wheat and fiber to refined wheat bread reduced the specific volume.

Oven spring of bread samples

The oven spring decreases significantly ($p< 0.05$) with increase in non- wheat flour, with sample S1 having the highest value and sample S6 with the least value. This could be due to the reduction in the gluten content. The gluten content of flour enables it to trap the gas produced during fermentation, yielding higher oven spring (Ocheme et al., 2010). A similar trend of decrease in oven spring were reported by Ukeyima et al. (2019); Ndife et al. (2011). They reported that addition of white kidney bean and soya bean flour to refined and whole wheat bread significantly reduced the oven spring of bread due to dilution of the gluten.

3.2 Proximate composition of bread samples

The proximate compositions of bread samples are presented in Table 3

Table 3: Proximate composition (%) of bread samples

Bread sample	Moisture	Ash	Fiber	Fat	Protein
S1	$30.03^{e}\pm0.01$	$0.67^{f}\pm0.01$	$0.50^{d}\pm0.20$	$1.09^{d}\pm0.05$	$9.67^{d}\pm0.14$
S2	$32.55^{d}\pm0.01$	$1.71^{e}\pm0.01$	$4.02^{c}\pm0.01$	$3.42^{c}\pm0.03$	$10.93^{c}\pm0.03$
S3	$32.58^{c}\pm0.03$	$1.82^{d}\pm0.02$	$4.10^{b}\pm0.01$	$3.46^{c}\pm0.02$	$10.99^{c}\pm0.01$
S4	$33.62^{b}\pm0.01$	$1.86^{c}\pm0.02$	$4.17^{ab}\pm0.01$	$3.55^{b}\pm0.02$	$11.44^{b}\pm0.01$
S5	$33.65^{a}\pm0.01$	$1.89^{b}\pm0.01$	$4.29^{a}\pm0.01$	$3.57^{b}\pm0.02$	$11.50^{b}\pm0.01$
S6	$33.67^{a}\pm0.02$	$1.94^{a}\pm0.02$	$4.31^{a}\pm0.01$	$3.64^{a}\pm0.03$	$12.21^{a}\pm0.02$

Key: Values are means of triplicate determinations ± S.D. Means followed by different superscript letters in the same column indicate significant difference at ($p<0.05$). **S1=** 100% refined wheat flour control 1, **S2=** 100% whole wheat flour control 2, **S3=** 90% whole wheat, 5% red kidney bean and 5% coconut flour blend, **S4=** 85% whole wheat, 10% red kidney bean and 5% coconut flour blend**, S5=** 80% whole wheat, 15% red kidney bean and 5% coconut flour blend, **S6=** 75% whole wheat, 20% red kidney bean and 5% coconut flour blend.

Moisture content of bread samples

There was a significant ($p < 0.05$) increase in the moisture content of the bread samples, with S1 having the lowest and S6 the highest value. The increase in moisture content with higher red kidney bean flour addition could be attributed to the rise in fiber and protein content, both of which are known to retain moisture. This finding is consistent with the report by Ukeyima et al. (2019), who incorporated white kidney bean into bread. The moisture content reported here is slightly higher, likely due to the additional incorporation of coconut, which is rich in dietary fiber and retains more moisture. High moisture content has been associated with a shorter shelf life of baked products, as it promotes microbial proliferation that leads to spoilage (Ndife et al., 2013).

Ash content of bread samples

There was significant ($p<0.05$) increase in the ash content of the bread with S1 having the least and S6 with the highest value. The data shows that the control samples (S1 and S2) are significantly ($p<0.05$) lower than the others. The increment of ash content in the fortified bread could probably be due to the higher ash content (1.5%) of whole wheat, 6.7% of coconut flour and 4.4% of red kidney beans flour as reported by Ndife et al. (2011); Sachithra et al. (2017); Noah and Adedeji, (2020) respectively. This result agree with works presented by Ramzy and Putra, (2019); Ukeyima et al. (2019); Manonmani et al. (2014), who in their separate work reported increased in ash content of bread fortified with legume (white and red kidney bean).

Fiber content of bread sample

The fiber content of the bread samples increased from S1 to S6 with the incorporation of red kidney bean. The fiber content of S2 to S6 were significantly ($p<0.05$) higher than the control S1. This could be due to the high fiber content of whole wheat flour, coconut flour and red kidney bean flour. This report agrees with works presented by Manonmani et al. (2014); Ukeyima et al. (2019), who reported that fortification of bread with coconut or white kidney beans increased the fiber content.

Fat content of bread samples

There was a significant ($p<0.05$) increase in fat content of the bread from S1 to S6 with the addition of red kidney bean and coconut flours. The high fat in the whole wheat breads, could be derived from the bran and germ inclusion (Ndife et al., 2013). The high fat in the test samples may also be due to the addition of red kidney beans and coconut flour. This report agrees with work presented by Ukeyima et al., (2019); Manonmani et al., (2014); Ndife et al., (2011); Ndife et al., (2013), who noted that the incorporation of non- wheat flour (red and white kidney beans) into refined wheat flour increased the fat content of bread. Fat is an essential component of tissues and a veritable source for fat-soluble Vitamins (A. D, E, K).

Protein content of bread samples

There was significant (P<0.05) increase in protein content with increase in red kidney bean substitution. The increase in protein content is due to high protein content of red kidney bean relative to other flours. Red kidney beans have been reported to contain 25.78% protein (Noah and Adedeji, 2020).while coconut flour has a protein content of 2.10% (Mihiranie et al., 2017) This trend agrees with those presented by Ndife et al., (2011); Manonmani et al., (2014); Ukeyima et al., (2019); Noah and Adedeji, (2020), who observed increased in protein content of wheat bread fortified with legumes. The protein content of fortified bread reported in this study is higher than that fortified only with red kidney beans flour; this could be due to the incorporation coconut flour. Protein is needed as building blocks for the body, necessary for growth, and for the repair of damaged tissues (Ramzy and Putra, 2019).

Carbohydrate Content of Bread Samples

Form the results there was a significant (P <0.05) decreased in the carbohydrate content with the addition of red kidney bean and coconut flour. The decreased could be due to the addition of red kidney beans which a good source of protein. This report agrees with finding by Ukeyima et al., (2019); Roy et al., (2020), who reported that increased in protein, ash fibre, moisture in food raw material often result to decreased in carbohydrates content. In comparison to the Nigerian regulatory standards for proximate values of whole wheat breads: The moisture, fat, fibre, protein and carbohydrate contents of the bread samples were within regulatory specifications of moisture 40% maximum; fat 10% maximum; fibre 6% maximum; protein 10% minimum; and carbohydrate 37% minimum (SON, 2004.).

3.3 Mineral content of bread samples

The mineral content of the bread is outlined in Table 4.

Table 4: Mineral content (mg/100g) of bread samples

Bread Samples	Potassium (K)	Sodium (Na)	Magnesium (Mg)	Phosphorus (P)	Iron (Fe)
S1	$30.13^{e}\pm0.02$	$15.86^{d}\pm0.17$	$11.43^{e}\pm0.04$	$10.61^{b}\pm0.27$	$0.84^{e}\pm0.13$
S2	$41.08^{d}\pm0.06$	$22.33^{c}\pm0.03$	$20.07^{d}\pm0.02$	$15.62^{a}\pm0.02$	$1.36^{d}\pm0.03$
S3	$41.23^{c}\pm0.00$	$22.37^{b}\pm0.03$	$20.11^{c}\pm0.01$	15.66a±0.01	$1.46^{c}\pm0.03$
S4	$41.42^{b}\pm0.00$	$22.38^{a}\pm0.02$	$20.14^{b}\pm0.02$	15.68a±0.01	$1.56^{b}\pm0.03$
S5	$41.43^{b}\pm0.00$	$22.40^{a}\pm0.02$	$20.17^{b}\pm0.02$	15.70a±0.02	$1.63^{ab}\pm0.02$
S6	$41.48^{a}\pm0.00$	$22.43^{a}\pm0.05$	$20.23^{a}\pm0.01$	$15.73^{a}\pm0.02$	$1.73^{a}\pm0.01$

Key: Values are means of triplicate determinations ± S.D. Means followed by different superscript letters in the same column indicate significant difference at ($p<0.05$). **S1=** 100% refined wheat flour control 1, **S2=** 100% whole wheat flour control 2, S3= 90% whole wheat, 5% red kidney bean and 5% coconut flour blend, **S4=** 85% whole wheat, 10% red kidney bean and 5% coconut flour blend**, S5=** 80% whole wheat, 15% red kidney bean and 5% coconut flour blend, **S6=** 75% whole wheat, 20% red kidney bean and 5% coconut flour blend.

Potassium (K) content of bread samples

There was a significant ($p<0.05$) increase in potassium content from S1 to S6, with S1 having the least and sample S6 having the highest. The increased in the K content of the samples may be due to, the use of whole wheat flour (S2) and increased in the level substitution of red kidney bean flour. These raw materials (bean and coconut) have been reported to be rich in potassium (Waziri et al., 2013). This work agrees with findings by Ndife et al. (2013); Winiarska-Mieczan & Kwiecień, (2011), who reported that whole wheat bread is rich in K than refined wheat bread. They explained that refining of wheat grain lead to remove of the bran which content high percentage of minerals. The result shows the K/Na ratio to be about 2:1. To protect against the adverse effect of high sodium intake the Na/K ratio of 1:1 is recommended. Sodium in combination with potassium is involved in maintaining proper homeostasis (acid balance) of body fluids and in nerves transmission (Ndife et al., 2013).

Sodium (Na) content of bread samples

There was a significant ($p<0.05$) increase in the sodium content of the samples with S1 (control 1) having the least and S6 with the highest. The increased in sodium content could be due to the present of sodium in whole wheat flour, red kidney bean and coconut flour (Winiarska-Mieczan & Kwiecień, 2011). This report agrees with findings by Ndife et al. (2013); Ciudad-Mulero et al. (2020), who reported whole wheat flour/products are rich in Na than refined wheat products. They explained that refining of wheat grain lead to remove of the bran which content high percentage of minerals. Also according to (Adelekan and Alamu , 2021) coconut flour improves the minerals content of bread when use as part of composite flour.

Magnesium (Mg) content of bread samples

There was significant ($p<0.05$) increase in the Mg content of the bread, with S1 having the least and S6 with the highest. The increased in Mg content of the bread samples could be due to the addition of red kidney bean and coconut flour which have been reported to be rich sources of Mg (Adelekan and Alamu, 2021). This work agree with finding by Ndife et al., 2013; Adelekan and Alamu, 2021), who reported that whole wheat products are rich in mg than refined wheat product. They explained that refining of wheat grain lead to remove of the bran which content high percentage of minerals.

Phosphorus (P) content of bread samples

There was significant ($p<0.05$) increased between control 1(S) and the other samples. The increased in the phosphorus content could be due to increase in the level of substitution of red kidney bean flour which have been reported to a rich source of phosphorus (Waziri et al., 2013; Winiarska-Mieczan & Kwiecień, 2011). This study agrees with finding reported by Ndife et al., (2013); Winiarska-Mieczan & Kwiecień, (2011), who reported high value of phosphorus in whole wheat flour and products than in refined.

4.6.5 Iron (Fe) content of bread samples

The control sample (S1) was significantly ($p<0.05$) lower in iron than the other samples. The increased in the iron content could be due to increase in the quantity of red kidney bean flour in the blend which have been reported to be rich source of iron (Ojobor et al., 2018). This report agrees with finding by Adelekan and Alamu, (2021); Ndife et al., (2013); Dimelu et al., (2019); Ayele et al., (2017) , who reported that addition of fruits and legumes to wheat flour increased the mineral content of the bread. It was also noted that whole wheat flour is rich in iron than refined wheat flour/products. They explained that refining of wheat grain lead to remove of the bran which content high percentage of minerals (Fe).

3.4 Vitamin content of bread samples

The vitamins content of the bread is outlined in Table 5.

Table 5: Vitamin content (mg/100g) of bread samples

Bread samples	Vitamin B1	Vitamin B2	Vitamin B3
S1	$0.37^{f}\pm0.03$	$0.68^{f}\pm0.01$	$0.76^{d}\pm0.00$

S2	$1.21^{e}\pm0.02$	$1.44^{e}\pm0.01$	$2.85^{c}\pm0.01$
S3	$1.28^{d}\pm0.02$	$1.48^{d}\pm0.01$	$2.86^{c}\pm0.02$
S4	$1.32^{c}\pm0.01$	$1.53^{c}\pm0.02$	$2.88^{b}\pm0.02$
S5	$1.37^{b}\pm0.02$	$1.57^{b}\pm0.02$	$2.90^{ab}\pm0.01$
S6	$1.42^{a}\pm0.02$	$1.60^{a}\pm0.02$	$2.93^{a}\pm0.04$

Key: Values are means of triplicate determinations ± S.D. Means followed by different superscript letters in the same column indicate significant difference at ($p<0.05$). **S1=** 100% refined wheat flour control 1, **S2=** 100% whole wheat flour control 2, **S3=** 90% whole wheat, 5% red kidney bean and 5% coconut flour blend, **S4=** 85% whole wheat, 10% red kidney bean and 5% coconut flour blend**, S5=** 80% whole wheat, 15% red kidney bean and 5% coconut flour blend, **S6=** 75 % whole wheat, 20% red kidney bean and 5% coconut flour blend.

Vitamin B1 (Thiamine) content of bread samples

There was a significant ($p<0.05$) increase in the thiamine content of the bread with S1 (control1) having the least and S6 with the highest value. The increased in thiamine content could resulted from increased in the proportion of red kidney bean flour. This work agrees with finding by Verem et al., (2021); Dimelu et al., (2019); Adejuyitan et al., (2020), who reported that addition of fruits or legumes to wheat increased the thiamine content of the bread.

Vitamin B2 content of bread samples

There was a significant ($p<0.05$) increase in the riboflavin (B2) content of the bread with S1 having the least and S6 with the highest value. The increased in the riboflavin resulted from increased in the red kidney bean. This work agrees with finding by Dimelu et al., (2019), who reported that incorporation of fruits or legumes to wheat flour increased the riboflavin content of bread.

Vitamin B3 (Niacin) content of bread samples

There was significant ($p<0.05$) increase in the niacin content of the bread with S1 having the least and S6 with the highest value. The increased in the niacin content is due to the incorporation of red kidney been and coconut which have been reported to content niacin (Ojobor et al., 2018; Romero-Arenas et al., 2013). This report is similar with findings by Dimelu et al., (2019), who reported increased in vitamin content wheat is incorporated with fruit and legumes.

Vitamin E content of bread samples

There was increase in the vitamin E content of the with S1 having the least and S6 with the highest. There was significant different ($p<0.05$) between sample S1 (contro1) and the other Samples. The increased in the vitamin E content of the bread could be due to the addition of coconut and red kidney bean which have been report to be sources of vitamin E. It is known that milling process could negatively affect vitamin E content, decreasing its content in white flours. In wheat grain, the germ fraction and aleurone tissue are very rich in tocopherols, therefore the refining process of wheat grain results in a substantial loss of this bioactive compound (Ciudad-Mulero et al., 2021) The results obtained in the present study were similar to those reported by Ciudad-mulero et al., (2021) that evaluated the tocopherols content in wheat flours, being total tocopherols content in whole wheat flour higher than refined wheat flour and bread. Also according to (Ciudad-mulero et al., 2020; Dimelu et al., 2019), noted that the addition of fruits or legumes to wheat bread increased the vitamin E content of the bread.

Conclusion

Acceptable quality bread, can be formulated from whole wheat, red kidney bean and defatted coconut flours blends. Substitution of wheat with red kidney beans and coconut flour significantly reduce the physical property (loaf volume, specific volume and oven spring) of bread while improving the proximate, minerals and vitamin content.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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