Nutritional and sensory evaluation of cookies made from red kidney beans (Phaseolus vulgaris L. var. vulgaris) and wheat flour (Triticum aestivum) blends

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ABSTRACT

Background: Snacks enrichments have gained considerable attention for their potential to address specific nutritional needs and promote overall health.

Objectives: This study evaluates the nutritional and sensory attributes of cookies made from red kidney beans (Phaseolus vulgaris L. var. vulgaris) and wheat flour (Triticum aestivum) blends.

Methods: Cookies produced from WRB (100% wheat flour), WRB 1 (80% wheat flour, 20% red kidney beans), WRB 2 (60% wheat flour, 40% red kidney beans), and WRB 3 (50% wheat flour, 50% red kidney beans) were subjected to nutrient analysis using standard analytical methods while sensory evaluation was carried out with a fifty panels using a nine- point hedonic scale.

Results: The proximate analysis shows that WRB 3 had the highest crude protein (12.00 ± 0.021), crude fibre (3.18 ± 0.024), ash (2.07 ± 0.021) and carbohydrate (67.55 ± 0.036). The mineral analysis shows that WRB 3 had the highest in zinc (215.4 ± 0.141) and magnesium (744.55 ± 0.212) while WRB had the lowest. The sensory evaluation reveals that the cookie samples had values ranging from 6.08 ± 1.116 to 6.96 ± 1.365 for the overall acceptance. The taste values were significantly ($p < 0.05$) higher ranging from 6.72 ± 1.472 to 6.78 ± 1.461.

Conclusion: The nutrient content of the cookies improves with the addition of red kidney beans flour. Cookies produced from red kidney bean and wheat flour blends can cater for the nutritional needs of consumers and sensory satisfaction.   The study highlights the importance of snacks as significant sources of essential nutrients for maintaining good health.

Keywords: Cookies, Evaluation, Nutrient, Quality, Sensory.

INTRODUCTION

Cookie is de·ned as being something consumed primarily for pleasure rather than for social or nutritive purpose and not ordinarily used in a regular meal (1). It is a form of Snacks that provide convenience and manageable portions, and they ful·ll short-term hunger (2). These snacks are often prepared from wheat flour and in some cases as composite with other cereal or legume flour. In Nigeria and throughout the world, snacks foods are widely spread and eaten among kids and adults because of their convenience both in preparation and circulation and also because of their distinctive taste (3).

Globally, it is estimated that one-third of people suffer from at least one form of micronutrient de·ciency (4). It is evident that micronutrient de·ciency has contributed to the global burden of disease and increased rate of morbidity and

mortality (5). According to the (6), deﬁciencies in iron, vitamin A and iodine are the most common around the world and can cause severe serious health issues. Magnesium, iron, and zinc are also essential minerals that play crucial roles in maintaining optimal health and well-being (7). However, research suggests that food modiﬁcation can contribute to micronutrient intake thereby reducing prevalence of dietary inadequacies (8). Legumes, belonging to the family Fabaceae, are the nutritious seeds derived from leguminous plants that can be consumed as pulses. They play a central role in the food system level for human consumption (9), as they are great plant-based sources of protein, iron, and ﬁbre. While it occurs that plant-based iron sources, referred to as non-heme iron, are not easily absorbed in the body, adequate preparation and adoption of nutrient enhancers (like vitamin C from fruit sources), can reduce or eliminate antinutrient content (10). Sources of leguminous foods include beans, lentils, and peas, and are great sources of carbohydrate, protein, fat, and minerals

Red Kidney Beans, a variety of Phaseolus vulgaris, are legumes rich in magnesium, zinc, iron, and other nutrients. Red Kidney Beans are native to Nigeria and are a very important food crop used in a variety of traditional dishes and are usually eaten well-cooked (11). It can be found cultivated in Esanland of Edo state, Nigeria and it is popularly known as Ikpakpa. However, the little awareness about this indigenous legume and the lack of easy culinary application are factors influencing its low usage (11). Red kidney beans are an excellent source of protein, minerals, low-fat dietary ﬁbre, and highly beneﬁcial phytonutrients (12). However, the little awareness about this indigenous legume and the lack of easy culinary application are factors influencing its low usage (13). In developing countries, beans are an affordable alternative for several people (14). Food legumes (dry beans and other pulses) have signiﬁcant importance in the human diet worldwide and occupy an important place in the global food supply chain asides promoting sustainable agricultural production systems (15).

Wheat is a grass crop widely cultivated for its seed, a cereal grain that is a worldwide staple food. It is a good source of protein, B-vitamin, minerals, and dietary ﬁbre (16).

Nutrition in humans is pivotal and malnutrition has severe effects on their health, household, and national development (17). (18) stated that uncontrollable stress changes eating patterns and the salience and consumption of hyper-palatable foods, that is, foods high in fat and sugar. This is also referred to as unhealthy comfort eating (19). Comfort foods tend to be high in calories, reﬁned sugars, and fat, and can be a leading cause of morbidity and mortality (20). Women, in condition like Iron deﬁciency anaemia (IDA) resulting from irregular menstruation is a common concern during perimenopause and can lead to complications such as osteoporosis and stress (18; 21). Despite the potential beneﬁts of functional foods, there are few researches on the utilisation of red kidney beans and wheat as ingredients in functional cookies speciﬁcally designed to address the nutritional needs of perimenopausal women. This knowledge gap hinders the development of innovative and effective dietary interventions to support the health and well-being of this population. The speciﬁc objectives are to enrich cookies using wheat flour and red kidney beans blends, assess their acceptability and determine their nutritional contents.

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MATERIALS AND METHODS
Procurement of raw materials
Fresh Red Kidney Beans were procured from M.D. Supermarket, Ile Ife, Osun state, Nigeria. Fresh date palm fruits, fresh lemon fruits, wheat flour, margarine, sugar, eggs, baking powder, milk powder, and flavours were obtained from Mayfair market, Ile-Ife, Osun state, Nigeria.

Preparation of coarse red kidney beans flour
The red kidney beans (Phaseolus vulgaris L.) were processed into a coarse flour-like form for optimal preparation of the cookies. The red kidney beans were cleaned to remove any foreign materials like stones, twigs, and leaves. Then it was sorted to remove any damaged or discoloured beans. The beans were then washed thoroughly to remove dirt or debris. After, the red kidney beans were soaked in water for four hours to reduce toxins, soften them and reduce cooking time. The soaked beans were then drained and boiled in fresh water at 100°C for 1 hour. The boiled red kidney beans were drained and dried in the oven at 150°C for 25 minutes. Finally, the boiled, dried red kidney beans were ground into coarse flour-like form.

Preparation of coarse date palm flour
The date palm fruits (Phoenix dactylifera L.) were cleaned and deseeded to retain only the flesh of the fruit used in the preparation of the functional cookie. Then, the date palm fruits were chopped into tiny bits and dried in the oven at 150°C for 10 minutes. The chopped, dried date palm fruits were then ground into coarse flour-like form.

Production of the cookies

Table 1: Recipe for the production of cookies

Ingredients	WRD	WRD1	WRD2	WRD3
Wheat flour (g)	400	320	240	200
Coarse red kidney beans flour (g)	0	80	160	200
Margarine (g)	150	150	150	150
Sugar (g)	130	0	0	0
Coarse date palm flour (g)	0	130	130	130
Whisked eggs (g)	125	125	125	125
Milk powder(g)	20	20	20	20
Vanilla extract (tsp)	2	2	2	2
Baking powder (tsp)	2	2	2	2
Lemon zest.(tsp)	0	2	2	2

Note: WRB: 0% coarse red kidney beans flour, 100% wheat flour (Control)
WRB 1: 20% coarse red kidney beans flour, 80% wheat flour
WRB 2: 40% coarse red kidney beans flour, 60% wheat flour
WRB 3: 50% coarse red kidney beans flour, 50% wheat flour

Method:

The cookies were prepared according to the method described by (22) with minor modi·cation. Sugar was added to margarine and mixed at medium speed until fluffy. Whole egg and milk powder were added during mixing and then mixing continued for about 30min. Sifted flour, baking powder and flavor were slowly added to the mixture and kneaded to form dough. It was then be rolled on a flat rolling board sprinkled with flour and cut out into required shapes and baked in an oven at 160 °C for 15 min. The preparation of the cookies took place at the Food and Nutrition Laboratory in the Department of Family, Nutrition and Consumer Sciences, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. The prepared samples were presented for analysis at the Central Laboratory, Obafemi Awolowo University, Ile-Ife, Nigeria. The four cookies samples produced were presented for analysis.
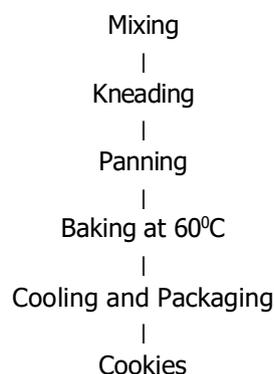
Mixing
|
Kneading
|
Panning
|
Baking at 60°C
|
Cooling and Packaging
|
Cookies

FIGURE 1: Flow chart for the production of Cookie

Proximate Analysis

The analysis was carried out at the Central Science Laboratory, Obafemi Awolowo University, Ile Ife. The proximate composition of the samples was analyzed using (23) methods. Moisture content was determined by the air oven method, protein content was determined by using the micro-kjeldahl method, while Soxhlet extraction method was used to determine fat. Ash content was obtained by weighing 5g of charred sample into a tarred porcelain crucible, then incinerated at 600OC for 6hr in ash muffle furnace until ash was obtained. Crude fibre was obtained by exhaustive extraction of soluble substances in a sample using H_2SO_4 and NaOH solution, after the residue was ashed and the loss in weight recorded as crude fibre. Total carbohydrate content was determined by difference.

Determination of mineral elements

The method described by [24] was used for the selected mineral analysis. The food samples were ashed at 550°C. The ash was then boiled with 10 ml of 20% HCL in a beaker, and then filtered into a 100 ml standard flask. This was made up to mark with the deionized water. The minerals were finally determined from the result using the Atomic Absorption Spectrophotometer.

Sensory evaluation

Sensory evaluation was used to assess the sensory characteristics of all cookie samples (WRB, WRB 1, WRB 2, and WRB 3). A total of fifty (50) untrained panel consisting of staff and students of Obafemi Awolowo University, Ile-Ife who were familiar with cookies participated in the evaluation and were briefed before the evaluation process. The samples were coded in an illuminated environment and placed in white flat disposable plates. The sensory attributes of appearance, colour, texture, flavour, taste, and overall acceptability were assessed using a nine-point hedonic scale. The scale ranged from 1 to 9, with 1 being "dislike extremely" and 9 being "like extremely." Assessors were also instructed to rinse their mouths thoroughly with water between tasting samples to prevent interference. Samples were rated alongside the control sample.

Statistical analysis

The data obtained were recorded as means, standard deviation and percentages and was analyzed using IBM SPSS Statistics version 23 software. Mean were separated by fisher less significant difference (LSD). Significant level was accepted at 5%.

RESULTS
Proximate composition of cookies

Table 2 shows that WRB 1 had the highest moisture content (13.72 ± 0.071%) while WRB 3 was rated lowest (12.74 ± 0.021%) in term of moisture content. The result shows that WRB 3 (2.07 ± 0.021) was rated highest in term of ash content, followed by WRB 2 (1.94 ± 0.014b). WRB 1 (3.52 ± 0.071) was high in ether, followed by WRB 2 (3.26 ± 0.071). Sample WRB 3 (12.00 ± 0.021) was rated highest in term of protein content, next was WRB 2 (11.94 ± 0.028). WRB 3 (3.18 ± 0.024a) was rated highest in term of fibre content, followed by WRB 2 (2.36 ± 0.036). Sample WRB 3 (67.55 ± 0.036) was rated highest in term of carbohydrate content while WRB 2 had the least (66.51 ± 0.092).

Table 2: Proximate analysis scores of the cookies

Sample	Moisture (%)	Ash (%)	Ether Extract (%)	Crude Protein (%)	Crude Fibre(%)	Carbohydrate (%)
WRB	15.69±0.205[a]	1.62±0.014[d]	4.62±0.042[a]	11.64±0.021[d]	1.14±0.021[d]	65.35±0.304[d]
WRB 1	13.72±0.071[b]	1.82±0.021[c]	3.52±0.071[b]	11.77±0.283[c]	2.19±0.021[c]	66.98±0.919[b]
WRB 2	13.53±0.028[c]	1.94±0.014[b]	3.26±0.071[c]	11.94±0.028[b]	2.36±0.036[b]	66.51±0.092[c]
WRB 3	12.74±0.021[d]	2.07±0.021[a]	2.47±0.021[d]	12.00±0.021[a]	3.18±0.024[a]	67.55±0.036[a]

Values are mean ± standard deviation of triplicate determination. Values on the same column with different superscripts are significantly different at p < 0.05.
KEYS
WRB: 0% coarse red kidney beans flour, 100% wheat flour (Control)
WRB 1: 20% coarse red kidney beans flour, 80% wheat flour
WRB 2: 40% coarse red kidney beans flour, 60% wheat flour
WRB 3: 50% coarse red kidney beans flour, 50% wheat flour

Mineral composition of cookies

The results were presented in Table 3.Sample WRB 3 (744.55 ± 0.212) was rated highest in term of Magnesium, followed by WRB 2 (707.35 ± 0.070), then WRB 1 (678.70 ± 0.141).The result shows that WRB 3 (94.65 ± 0.071) was rated highest in term of Iron followed by WRB 2 (94.45 ± 0.071) and WRB 1 (94.40 ± 0.142) was rated lowest. Sample WRB 3 (215.4 ± 0.141) was rated highest in term of Zinc, followed by WRB 2 (180.1 ± 0.142), and then WRB 1 (165.0 ± 0.260).

Sensory evaluation of cookies

Table 4 shows that WRB 1(7.00 ± .001) was preferred in terms of appearance, followed by WRB 2(6.96 ± 1.068), and WRB 3 (6.88 ± 1.206) was rated lowest in terms of appearance. WRB 1, WRB 2, and WRB 3 were less preferred because of the dark appearances. WRB 1 was preferred next to the control compared to WRB 2, and WRB 3 which gave the darkest appearance. Sample WRB 1(6.98 ± 1.234) was rated high, followed by WRB 2(6.84 ± 1.057), and WRB 3 (6.84 ± 1.131) was rated lowest in terms of colour. Sample WRB 3 (6.78 ± 1.461) was next to the control followed by WRB 2 (6.74 ± 1.404), and WRB 1 (6.72 ± 1.472) in taste. The result shows that WRB 1 (6.80 ± 1 429), was the highest, followed by WRB 2 (6.64 ± 1.367c), and WRB 3 (6.26 ± 1.397) was rated lowest in terms of texture. Sample WRB 3 (6.88 ± 1.400) was preferred to other smoothie samples in terms of flavour. Sample WRB 1 (6.96 ± 1.365) was the

Table 3: Mineral composition scores of the cookies

Sample	Mg (mg/l)	Fe (mg/l)	Zn (mg/l)
WRB	470.17 0.071[d]	114.30 ±0.021[a]	110.05 ± 0.710[d]
WRB 1	678.70 ± 0.141[c]	94.40 ± 0.142[d]	165.0 ± 0.260[c]
WRB 2	707.35 ± 0.070[b]	94.45 ± 0.071[c]	180.1 ± 0.142[b]
WRB 3	744.55 ± 0.212[a]	94.65 ± 0.071[b]	215.4 ± 0.141[a]

Values are mean ± standard deviation of triplicate determination. Values on the same column with different superscripts are signi·cantly different at p< 0.05.
KEYS
WRB: 0% coarse red kidney beans flour, 100% wheat flour (Control)
WRB 1: 20% coarse red kidney beans flour, 80% wheat flour
WRB 2: 40% coarse red kidney beans flour, 60% wheat flour
WRB 3: 50% coarse red kidney beans flour, 50% wheat flour

Table 4: Sensory evaluation of the cookies.

Sample	Appearance	Colour	Taste	Texture	Flavour	General Acceptability
WRB	8.06 ± 1.041[a]	8.100±0.931[a]	8.12 ±1.118[a]	7.84±1.131[a]	8.04±0.903[a]	8.18±0.919[a]
WRB 1	7.00 ±1.001[b]	6.98 ±1.234[b]	6.72 ±1.472[d]	6.80±1.429[b]	6.56±1.680[d]	6.96±1.365[b]
WRB 2	6.96 ± 1.068[c]	6.84 ±1.057[d]	6.74 ±1.404[c]	6.64±1.367[c]	6.80±1.391[c]	6.08±1.116[d]
WRB 3	6.88 ±1.206[d]	6.84 ±1.131[c]	6.78 ±1.461[b]	6.26±1.397[d]	6.88±1.400[b]	6.66±1.289[c]

Values are mean ± standard deviation of triplicate determination. Values on the same column with different superscripts are signi·cantly different at p< 0.05
KEYS
WRB: 0% coarse red kidney beans flour, 100% wheat flour (Control)
WRB 1: 20% coarse red kidney beans flour, 80% wheat flour
WRB 2: 40% coarse red kidney beans flour, 60% wheat flour
WRB 3: 50% coarse red kidney beans flour, 50% wheat flour

highest followed by WRB 3 (6.66 ± 1.289) and WRB 2 (6.08 ± 1.116) was rated lowest in terms of general acceptability.

DISCUSSION

The crude protein, ash and crude fibre levels of the cookies increased with the addition of red kidney beans flour. Proteins are essential component of diet needed for human survival which basic function is to supply adequate amounts of required amino acids in nutrition. This provision by the addition of red kidney beans flour is in agreement with similar study on Bambara nut (15). Additionally, the modified cookie with red kidney beans flour offers the advantage of being a source of dietary fibre from the beans. Dietary fibre is important for digestive health and can help manage weight, regulate blood sugar levels, and support cardiovascular health. Macronutrient imbalance f rom intake of carbohydrates, proteins, and fats, can affect overall energy levels and contribute to weight management i ssues. Studies have shown that people may experience alterations in carbohydrate metabolism and a shift towards increased fat accumulation (7; 25; 26). By incorporating fibre-rich foods into their daily meals, women can take proactive steps towards maintaining their health and well-being during this transitional phase of life. The increase in carbohydrate in the modified cookies is due to the presence of date palm which is rich in carbohydrate (26). The incorporation of red kidney beans flour and replacement of sugar with dates accounts for the increase in zinc content of the modified samples (WRB 1, WRB 2, WRB 3), as compared to the control however, WRB 3 had the highest zinc composition. Also, sample WRB 3 contained higher levels of magnesium which can be particularly beneficial for women and individuals seeking snacks rich in these minerals. Magnesium has been associated with various health benefits for women, including conditions l ike PCOS, premenstrual syndrome, and menopause (27). However, a higher intake of vegetables, greens, beans, total fruits, whole fruits, and whole grains can reduce the risk of osteoporosis among elderly adults (27). Higher moisture content can increase the fast rate of spoilage and reduce the cookies' shelf stability. In this study, WRB 3 demonstrated a lower moisture content compared to the control, indicating better shelf stability. The shelf life of food and snacks is an important consideration because some people prefer to stock up in bulk to save energy, time, and cost. The fat content contributes to the mouth feel and texture of the cookie samples. While the impact of menstruation on magnesium and zinc levels is not as extensively studied as iron, there is evidence to suggest that menstrual blood loss can contribute to the depletion of these micronutrients. (26, 21) stated that zinc is an essential microelement that plays many important functions in the body, and crucial for the regulation of cell growth, hormone release, immunological response and reproduction. (18) stated that blood loss as a result of irregular menstruation is a common cause of iron deficiency anaemia (IDA) in women. In a study by (27), it was also revealed that patients with a history of IDA had a higher incidence of osteoporosis. In terms of the sweetener used, the modified cookies using date palm as a natural sweetener instead of sugar provides an alternative option for individuals who prefer to limit their refined sugar intake. This can be particularly relevant for women who may be mindful of their overall sugar consumption for health reasons. Interestingly, sensory evaluations showed that cookies made from 20% Coarse Red Kidney Beans Flour and 80% Wheat Flour was the most preferred in terms of appearance, colour, texture, flavour, and overall acceptability. This finding suggests that it can be an appealing option for those seeking sensory-pleasing cookies while also providing the benefits of magnesium, iron, and zinc and this is in agreement with the survey conducted by (26).

CONCLUSION

The study shows that the cookies made from Coarse Red Kidney Beans Flour and Wheat Flour exhibited promising results. The cookies produced from 80% wheat flour and 20% red kidney beans flour was most preferred largely because of the colour, texture, and taste.

The modified cookies with red kidney beans flour also offered the advantage of being a source of macro and micronutrient contributing to health and overall well-being. Incorporating red kidney beans flour into cookie formulations could be very beneficial to women and anyone seeking to snack on healthy cookies, considering sensory preferences and nutrient content.

CONFLICT OF INTEREST
No conflict of interest declared

1. Matz, S.A. (1993). Snacks. Food Technology (3 Ed). New rd York. Van Nostrand Reinhold.

2. Tettweiler, P. (1991). Snack food worldwide. Food Technology, 45:58-61.

3. Adegunwa, M. O., Ganiyu, A. A., Bakare, H. A. & Adebowale, A.A. (2014). Quality evaluation of composite millet-wheat Chinchin. Agriculture and Biology Journal of North America, 5(1): 33-39.

4. HLPE, A. (2017). Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome: HLPE.

5. Han, X., Ding, S., Lu, J., & Li, Y. (2022). Global, regional, and national burdens of common micronutrient de·ciencies from 1990 to 2019: A secondary trend analysis based on the Global Burden of Disease 2019 study. eClinical Medicine, 44: 101299.

6. World Health Organization. (2004). Food and Agricultural Organization (FAO). Vitamin and Mineral Requirements in Human Nutrition (2nd Ed.). WHO; Geneva, Switzerland.

7. Zieli ska, M., Łuszczki, E., & Dere , K. (2023). Dietary Nutrient De·ciencies and Risk of Depression. Nutrients, 15(11): 2433. MDPI AG.

8. Tang, K., Adams, K. P., Ferguson, E. L., Woldt, M., Kalimbira, A. A., Likoswe, B., … & Joy, E. J. (2022). Modeling food forti·cation contributions to micronutrient requirements in Malawi using Household Consumption and Expenditure Surveys. Annals of the New York Academy of Sciences, 1508(1): 105-122.

9. Voisin, A. S., Guéguen, J., Huyghe, C., Jeuffroy, M. H., Magrini, M. B. & Meynard, J. M. (2014). Legumes for feed, food, biomaterials and bioenergy in Europe: a review. Agronomy for Sustainable Development, 34: 361–380.

10. Fernandes, A. C., Nishida, W., & Da Costa Proenca, R. P. (2010). Influence of soaking on the nutritional quality of common beans (Phaseolus vulgaris L.) cooked with or without the soaking water: a review. International Journal of Food Science & Technology, 45(11): 2209-2218.

11. Alagbe, E. E., Okoye, G. C., Amoo, T. E., Adekeye, B. T., Taiwo, O. S., Adeyemi, A. O., & Daniel, E. O. (2022). Spontaneous and controlled fermentation to improve nutritional value of Ikpakpa beans, Phaseolus vulgaris. Cogent Engineering, 9(1): 83-103.

12. Bazzano, L. A., Thompson, A. M. & Tees, M. T., (2011). Non-soy legume consumption lowers cholesterol levels: A meta- analysis of randomized controlled trials. Nutrition Metabolism Cardiovascular Discovery, 21(2): 94-103.

13. Siddiq, M., Uebersax, M. A., & Siddiq, F. (2021). Global Production, Trade, Processing and Nutritional Pro·le of Dry Beans and Other Pulses. Wiley Online Library.

14. Akeresola, R.A., & Gayawan, E. (2020). Analysis of the spatial patterns of malnutrition among women in Nigeria with a Bayesian structured additive model. GeoJournal, 85: 81–92. 15.

15. Gordon, J. L., Halleran, M., Beshai, S., Eisenlohr-Moul, T. A., Frederick, J., & Campbell, T. S. (2021). Endocrine and psychosocial moderators of mindfulness-based stress reduction for the prevention of perimenopausal depressive symptoms: A randomized controlled trial. Psychoneuroendocrinology, 130: 105277.

16. Dolotov, O. V., Inozemtseva, L. S., Myasoedov, N. F., & Grivennikov, I. A. (2022). Stress-Induced Depression and Alzheimer's disease: Focus on Astrocytes. International journal of molecular science, 23(9): 4999.

17. Yau, Y. H. C., & Potenza, M. N. (2013). Stress and Eating Behaviour. Mineral Endocrinology, 38(3):255-67.

18. Finch, L. E., Cummings, L. R., & Tomiyama, A. J. (2019). Cookie or clementine? Psychophysiological stress reactivity and recovery after eating healthy and unhealthy comfort foods. Psychoneuroendocrinology, 107: 26-36.

19. Mokdad, A. H., Ballestros, K., Echko, M., Glsenn, S., Olsen, H. Kasaeian, A., & Murray, C. J. L. (2018). U.S. Burden of Disease Collaborators, The State of US Health, 1990–2016: Burden of Diseases, Injuries, and Risk Factors Among US States. JAMA, 319(14): 1444–1472

20. Pan, M., Chen, L., Tsao, H., & Chen, K. (2017). Iron De·ciency Anemia as a Risk Factor for Osteoporosis in Taiwan: A Nationwide Population-Based Study. National Library of Medicine, 9(6): 616. doi:

21. Nasiadek, M., Stragierowicz, J., Klimczak, M., and Kilanowicz, A. (2020). The Role of Zinc in Selected Female Reproductive System Disorders. Nutrients, 12(8): 223.

22. Lai, H. M., & Lin, T. C. (2006). Bakery products: Science and technology. In Y. H. Hui (Ed.), Bakery products science and technology.

Blackwell Publishing Ames, USA. Pp. 3-65.

23. AOAC International. (2019). Official Methods of Analysis (21st Ed.). AOAC International.

24. Porri, D., Biesalski, H. K., Limitone, A., Bertuzzo, L., & Cena, H. (2021). Effect of magnesium supplementation on women's health and well-being. NFS Journal, 23: 30-36.

25. Ko, S., & Kim, H. (2020). Menopause-Associated Lipid Metabolic Disorders and Foods Beneficial for Postmenopausal Women. Nutrients. 12(1), 202. https://doi.org/10.3390/nu12010202.

26. Folorunso, A.A., Soyebo, K.O., Bakare, K.O., & Oladeji, D. (2021). Quality Evaluation of Biscuits Using Citrus Peel and Date Palm Fruits. Nigerian Journal of Nutritional Sciences, 42(1):188-194.

27. Fan, Y., Ni, S., & Zhang, H. (2022). Association between Healthy Eating Index-2015 total and component food scores with osteoporosis in middle-aged and older Americans: a cross-sectional study with U.S. National Health and Nutrition Examination Survey. Osteoporosis International, 33: 921–929.

APPENDIX

RED KIDNEY BEANS

RED KIDNEY BEANS COARSE FLOUR

100% WHEAT FLOUR

80% WHEAT FLOUR AND 20% RED KIDNEY BEANS FLOUR

60% WHEAT FLOUR AND 40% RED KIDNEY BEANS FLOUR

50% WHEAT FLOUR AND 50% RED KIDNEY BEANS FLOUR