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Comparative Studies on Nutritive and Antinutritive Values of Cowpea (*Vigna unguiculata* L. Walp) and Rice *(Oryza sativa* L.)

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Abstract

The study was carried out on proximate, mineral and antinutritional compositions of cowpea (*Vigna unguiculata* L. Walp*)* and rice (*Oryza sativa* L.) in order to compare the nutritional and antinutritional composition of these two important food crops. The standard analytical techniques were used for all the determinations and analyses. The calculated parameters were metabolized energy, mineral safety index (MSI), mineral ratios of some minerals. The results of the proximate composition (%) revealed that crude fat (2.46 ± 0.07), moisture (5.85 ± 0.03) and total energy (1539.25 kj/100g) contents were higher for rice than cowpea (1.61 ± 0.06, 4.58 ± 0.10 and 1489.27 kj/100g), respectively while cowpea had higher level of crude protein (10.10 ± 0.14) and crude fiber (4.67 ± 0.17) than the crude protein (9.10±0.13) and crude fibre (2.37±0.08) of rice. No mineral had a deleterious value in the MSI because they had their table value (TV) > calculated value (CV). The phytate, tannin and oxalate concentrations were higher in rice (90.08±0.52%, 6.01±0.01 mg/100g and 5.05±0.18%) compared with that of the cowpea (40.45±2.68%, 3.11±0.08 mg/100g and 4.37±0.09%) while cowpea had higher concentrations in total phenol (24.79±2.55%) and flavonoids (4.55±0.07%) than rice. Antinutritional analysis showed that rice had higher levels of phytic acid and tannins, which can reduce the bioavailability of minerals, while flavonoids were higher in cowpea. This study concludes that both rice and cowpea are important sources of nutrients and should be consumed in combination to ensure a balanced diet. Likewise, the high contents of some of the antinutrients may pose a nutritional problem in their consumption.

Keywords: Antinutritional factors, cowpea, minerals, proximate, rice

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Introduction

In recent times, the global landscape has witnessed a palpable uptick in the cost of living, a trend particularly pronounced in developing nations like Nigeria. This economic shift reverberates across society, significantly impacting food availability and nutrient accessibility, especially among the most vulnerable segments of the population. Against this backdrop, traditional African diets, characterized by their reliance on carbohydrate-rich staples and limited intake of animal proteins, come under heightened scrutiny as households strive to navigate escalating food prices.

Within this complex socio-economic milieu, access to an ample food supply and essential healthcare emerges as fundamental human rights crucial for societal progress. Food, comprising a spectrum of vital nutrients such as carbohydrates, proteins, fats, vitamins, minerals, and water, stands as the bedrock of human sustenance and daily functionality. Proteins, in particular, stand out as indispensable building blocks for all living cells, intricately involved in myriad cellular processes vital for health and well-being. In the realm of human nutrition, crop proteins sourced from cereal and legume seeds emerge as primary sources of dietary protein, playing a pivotal role in meeting nutritional needs [1].

Cowpea (*Vigna unguiculata* L.) is an important and annual herbaceous legume (family Fabaceae) predominantly grown in Africa and South–East Asia and is an important staple crop providing an affordable source of protein [2]. It is thought to have originated from central Africa and is now grown in many parts of the tropics like West Africa, India and central Africa. Cowpea is the most widely grown and distributed legumes in Nigeria. The chemical composition of cowpea is similar to that of most edible legumes. The crop is considered the second most important food grain legume and constitutes a cheap source of protein for humans. Cowpea grain is nutritious, inexpensive and is regarded as a nutrient dense food with low energy density.

It is also an excellent source of thiamine, folic acid, niacin, riboflavin and biotin [3] and it plays a great role in alleviating malnutrition poverty and in developing countries. Generally, proteins derived from grain legumes are rich in several amino acids, such as lysine and tryptophan; but deficient in sulfur-based amino acids methionine and cysteine − a factor that makes these grains slightly inferior to animal-derived proteins [4].

Plate 1: Cowpea (*Vigna unguiculata* L.)

Other important source of food is rice (*Oryza sativa* L.) which is a monocot plant of the genus Oryza and family Poaceae which has been cultivated for more than 10,000 years [5]. Awareness on nutritive value and health benefits of rice is of vital importance as rice is one of the most important cereals in human nutrition and is consumed by over 50% of the global population. Rice is not only a very important source of energy but also contains micronutrients such as vitamins, minerals and secondary metabolites. The dietary minerals in rice include calcium, iron, magnesium, phosphorous, potassium, sodium, zinc, copper and selenium.

Plate 2: Rice (*Oryza sativa* L.)

The antinutrients or antinutritional factors are substances generated naturally in crops by their normal metabolism which exert effects contrary to optimum nutritional contents of these crops. They are natural or synthetic compounds that interfere with the absorption of nutrients [6]. Antinutrients can also be defined as biological compounds present in human or animal foods that reduce nutrient utilization thereby contributing to impaired gastrointestinal and metabolic performance. The presence of antinutritional factors in cowpea may reduce the acceptability of its food products and have negative impact on it protein and mineral bioavailability [7]. Antinutrients can inhibit human and animal growth by causing discomfort and stress in humans and animals upon consumption. Some of these antinutrients have attracted a considerable interest of researchers owing to their diverse range of biological activities which may be beneficial for humans [8].

This work is aimed at assessing the nutritive and antinutritive values of cowpea (*Vigna unguiculata* L. Walp) and rice (*Oryza sativa* L.) grown in Nasarawa State, Nigeria so as to add our findings to the food composition table.

Materials and Methods

Samples collection and treatment

The two different samples of beans and rice were collected directly from farmers in Shabu Development Area, Nasarawa state, North-central, Nigeria. Selection of default seeds was done manually by hand picking to remove impurities such as stones and dust from the samples. The beans and rice were sun dried for a period of 3 days. The dried samples were pulverized using a manual process of a mortar and pistol, ground into powder using food blender and later stored in plastic container prior to the analysis.

Proximate analysis

The ash, moisture, crude fat, crude protein (N x 6.25), crude fibre and carbohydrate (by difference) were determined in accordance with the methods of AOAC [9]. All proximate analyses of the sample flour were carried out in triplicate and reported in percentage. All chemicals were of Analar grade.

Mineral analysis

The potassium and sodium were determined using a flame photometer (Model 405, Corning UK). Phosphorus was determined by Vanadomolybdate colourimetric method [10]. All other metals were determined by atomic absorption spectrophotometer (Perkin–Elmer Model 403, Norwalk CT). All the minerals determined were reported in mg/100 g sample.

Anti–nutrient content determination

The contents of tannin, alkaloid, saponin, phytate, oxalate, total phenol, flavonoids and cyanide were determined on each of the sample flours by methods described by some workers [3, 7].

Statistical analysis of the samples

The fatty acid values were obtained by multiplying crude fat value of each sample with a factor of 0.8 (i.e. crude fat x 0.8 = corresponding to fatty acids value). The energy values were calculated by adding up the carbohydrate x 17 kJ, crude protein x 17 kJ and crude fat x 37 kJ for each of the samples. Errors of three determinations were computed as standard deviation (SD) for the proximate composition.

Results and Discussion

The proximate composition of cowpea (*Vigna unguiculata* L. Walp*)* and rice (*Oryza sativa* L.) is presented in Table 1. It shows that moisture content of cowpea was (4.58%) while rice was (5.85%) which is in agreement with most literature for rice [11]. Moisture content invariably affects the quality and palatability of rice [12] and plays a significant role in determining the shelf life and controls the rate of deterioration and infestation of the grains during storage [13].

Fat provides very good sources of energy, protects internal tissues, contributes to important oil processes and aids in transport of fat soluble vitamins. The crude fat content of cowpea and rice were 1.61 and 2.46% respectively. Fat content influences the taste of cooked rice because rice with high fat tends to be more palatable and have less starch. Fat content in this study were comparatively somewhat similar to the ones obtained by Fari *et al.* [14]; [15]. The value of crude protein content in cowpea is higher than that of rice.

It is not surprised that the carbohydrate value of rice was high compared with that of the cowpea because of its high contents of crude protein and crude fat since carbohydrate is obtained by difference between 100 and the summation of other parameters (Table 1). The crude fiber in cowpea, however, was higher compared to the value obtained for rice (Table 1). Fibre helps to maintain the health of the gastrointestinal tract, but in excess may bind trace elements, leading to deficiencies of iron and zinc [16].

The metabolizable energy in the present study showed that rice has energy concentrations that are more favourable compared with cowpea [17]. The calculated fatty acids value of the rice (1.99%) is much higher than that of cowpea (1.29%).

Table 1: Proximate composition (%) of cowpea (*Vigna unguiculata* L. Walp*)* and rice (*Oryza sativa* L)

Parameter	Cowpea	Rice	Mean	SD	CV%
Crude protein	10.10 ± 0.14	9.10 ± 0.13	9.60	0.711	7.40
Crude fibre	4.67 ± 0.17	2.37 ± 0.08	3.52	1.63	46.31
Crude fat	1.61 ± 0.06	2.46 ± 0.07	2.04	0.60	29..41
Ash	5.04 ± 0.06	4.13 ± 4.99	4.59	0.64	13.94
Moisture	4.58 ± 0.10	5.85 ± 0.03	5.22	0.90	17,24
[b]Carbohydrate	74.00 ± 0.33	76.09 ± 5.15	75.05	1.48	1.97
[c]Fatty acid	1.29	1.99	1.64	0-49	29.89
[d]Energy (kj/100 g)	1489.27	1539.25	1514.26	35.34	2.33

[a]Values are ± standard deviations (n = 3); [b]Carbohydrate (%) calculated as 100 – total of other components; [c]Calculated fatty acids (0.8 x Crude fat); [d]Calculated metabolizable energy (kJ/100g) (Protein x 17 + Fat x 37 + Carbohydrate x 17)

Table 2: Comparative mineral compositions (mg/100 g) of cowpea (*Vigna unguiculata* L. Walp*)* and rice (*Oryza sativa*)

Mineral (mg/100 g)	Cowpea	Rice	Mean	SD	CV%
Na	26.51	25.48	25.99	0.73	2.81
Ca	83.11	81.69	82.40	1.01	1.23
K	284.78	281.65	283.21	2.21	0.78
Zn	9.12	8.85	8.98	0.19	2.12
P	241.19	258.33	249.76	0.01	0.00
Mg	151.41	142.45	146.93	6.34	4.32
Fe	13.84	12.84	13.34	0.71	5.32
Cu	1.41	1.36	1.41	0.07	0.47
Na/K	0.09	0.09	0.09	0.00	0.00
Ca/P	0.11	0.32	0.30	0.18	0.61
Na/Mg	0.18	0.18	0.18	0.00	0.00

Na/K = Sodium to potassium ratio; Ca/P = Calcium to phosphorus ratio; Na/Mg = Sodium to magnesium ratio; SD = Standard deviation; CV = Coefficient of variation

The mineral profiles of cowpea and rice are displayed in Table 2. Of all the minerals determined, P is the most abundant having values of 2411.90 and 2583.29 mg/100 g for cowpea and rice respectively. It is followed by K (284.78 and 281.65 mg/100 g) and Mg (151.41 and 142.45 mg/100 g) for both cowpea and rice. Phosphorus is always found with Ca in the body both contributing to the blood formation and supportive structure of the body [18]. Low Ca/P ratio facilitates decalcination of Ca in the bone leading to low Ca level in the bones while Ca/P ratio above two helps to increase the absorption of Ca in the small intestine [19]. The values of Ca/P ratios in the present study are less than 1. Magnesium was found to be high in both samples (151.41 and 142.45 mg/100 g), respectively. Mg is required for bone formation which maintains the electrical potential in nerves [20]. The adrenal glands play an essential role in regulating sodium retention and excretion. Studies have also shown that Mg will affect adrenal cortical activity and results in increase in Mg retention [20]. The ratio of sodium to potassium in the body is of great concern for the prevention of high blood pressure. Na/K ratio less than one is recommended [21]. The Na/K ratio value was 0.09 each for cowpea and rice. This indicates that regular consumption of these foods may prevent high blood pressure. Na/Mg value (0.18) is also presented. Copper and Zn are intricately related to the hormones, progesterone and estrogens, respectively and their tissue levels may be indirectly reflective of the status of these hormones within the body [20]. The CV% varied from 0.47 in Cu to 5.32% in Fe.

The mineral safety index (MSI) values of Na, Ca, Mg, Cu, Zn, Fe and P of cowpea and rice are presented in Table 3. The standard mineral safety index values for the elements are Na (4.8), Ca (10), Mg (15), Cu (33), Zn (33), Fe (6.7) and P (10) [22]. The explanation on the MSI can be understood as follows: Taking Na as example: the recommended adult intake (RAI) of Na is 500 mg; its minimum toxic dose (MTD) is 2,400 or 4.8 times the recommended daily average (RAA) which is equivalent to MSI of Na [22]. This explanation goes for the other minerals whose MSI were determined. All the minerals have their table values (TVs) > calculated value (CV) giving positive differences with corresponding low percentage differences. The CV of MSI gave an indication that none of the minerals was high enough to the deleterious levels when consumed in cowpea or rice [23].

Table 3: Mineral safety index (MSI*) of Na, Ca, Mg, Cu, Zn, Fe and P in cowpea (*Vigna unguiculata L Walp)* and rice (*Oryza sativa*)

Mineral	RAI (mg)	TV of MSI	Calculated value (CV)	
			Cowpea	Rice
Na	500	4.8	0.25	0.24
Ca	1200	10	0.69	0.68
Mg	400	15	5.68	5.34
Cu	3	33	15.95	14.96
Zn	15	33	20.06	19.47
Fe	15	6.7	6.18	5.74
P	1200	10	2.01	2.15

RAI = Recommended adult intake; TV = Table value; * = No MSI standard for K and Mn

Table 4: Antinutritional compositions of cowpea (*Vigna unguiculata* L. Walp) and rice (*Oryza sativa* L.)

Antinutrient	Cowpea	Rice	Mean	S.D	CV%
Oxalate (%)	4.37 ± 0.09	5.05 ± 0.18	4.71	0.48	10.19
Saponin (%)	0.80 ± 0.00	0.20 ± 0.00	0.50	0.42	84.00
Alkaloids (%)	4.85 ± 0.07	5.18 ± 0.04	5.02	0.23	4.58
Flavonoids(%)	4.55 ± 0.07	0.63 ± 0.04	2.59	2.77	106.95
Totalphenol(%)	24.79± 2.55	22.10 ± 0.04	23.43	1.90	8.10
Cyanide (mg/100g)	0.14 ± 0.02	1.10 ± 0.02	0.62	0.68	109.68
Phytate (mg/100g)	40.45± 2.68	90.08 ± 0.52	65.27	35.09	53.76
Tannin (mg/100g)	3.11 ± 0.08	6.01 ± 0.01	4.56	2.05	44.96

Values are expressed as mean ± S.D of duplicate determinations

The antinutrient contents are displayed in Table 4. Dietary anti–nutritional factors such as alkaloid, oxalate, tannin, saponin, cyanide and phytate have been reported to adversely affect the digestibility of protein, protein quality of foods and bioavailability of amino acids [24, 25]. Oxalate was found in cowpea to be 4.37 mg/100 g while 5.05 mg/100 g in rice. Excess consumption of oxalate can cause corrosive gastroenteritis oxalate serves as chelating agents and may chelate many toxic metals such as mercury and lead, but one major concern is its ability to rap heavy metals in the tissues of living organisms thereby making elimination of them very difficult. Oxalate binds to calcium and prevents its absorption in human body [26, 27]. The values of saponin were 0.80 and 0.20 mg/100 g for cowpea and rice, respectively. It has been reported that dietary saponins exert various biological benefits such as anti–inflammatory, anti–diabetic and serve as protective functions like gastro–protective, hepatoprotective and hypolipidemic [28 - 30]. Alkaloid values in cowpea (4.85 mg/100 g) and rice (5.18 mg/100 g) were very low compared to the reported values of 8.6% (scarlet runner bean) and 9.6% (lima bean) and 5.0% (black turtle bean) [24]. Consumption of high tropane alkaloids will cause rapid heartbeat, paralysis and in fatal case, lead to death. The tannin content in cowpea (3.11 mg/100 g) is much lesser than that of rice (6.01 mg/100 g). The nutritional effects of tannins are mainly related to their interaction with protein due to the formation of complexes [28]. Tannin acid may decrease protein quality by decreasing palatability and digestibility. Other nutritional effects which have been attributed to tannins include interference with the absorption of iron, a possible carcinogenic effect and damage to the intestinal tract [30]. Cyanide is the chemical substance responsible for tissue hypoxia and chronic exposure to it particularly hydrogen cyanide may cause respiratory, neurological, thyroid and cardiovascular defects [31]. The cyanide content in the rice (1.10 mg/100 g) is higher than that of cowpea (0.14 mg/100 g). The phytate content in both samples is too high; 40.45 and 90.08 mg/100g recorded for cowpea and rice, respectively. Phytate is a salt form of phytic acid and acts as a strong chelator, forming protein and mineral phytic acid complexes thereby reducing protein and mineral availability [32–34]. It chelates metal ions such as Ca, Mg, Zn, Cu and Fe to form insoluble complexes that are not readily absorbed from the gastrointestinal tract [35].

Conclusion

The comprehensive analysis delving into the proximate, mineral, and antinutritional compositions of rice and cowpea illuminates their pivotal roles as cornerstone elements of nutrient-rich diets. Despite their shared status as dietary staples, a closer examination reveals stark contrasts in their nutritional profiles. Rice, with its higher moisture content and crude fat levels, stands in juxtaposition to cowpea's remarkable richness in crude protein, ash, and crude fiber. The divergence extends beyond macronutrient composition to encompass mineral content as well. Cowpea emerges as the frontrunner, boasting superior concentrations of all scrutinized minerals except phosphorus. This nuanced understanding of mineral composition underscores the potential of cowpea as a potent source of essential nutrients. However, it's not just about what these staples offer in terms of nutrients; their antinutritional factors also play a crucial role. Rice, unfortunately, exhibits elevated levels of phytate, tannin, and oxalate, compounds infamous for their hindrance of mineral absorption. In stark contrast, cowpea presents a more favorable profile, characterized by lower concentrations of these inhibitors, while concurrently showcasing higher levels of total phenols and flavonoids, which offer potential health benefits. These disparities highlight the necessity of a balanced dietary approach that incorporates both rice and cowpea. Such a strategy ensures not only optimal nutrient assimilation but also mitigates the adverse effects of antinutritional factors present in these staples. By acknowledging the unique attributes of each food item, tailored dietary recommendations can be formulated to promote holistic nutrition and cultivate healthier dietary habits within communities.

In essence, this study serves as a poignant reminder of the nutritional diversity inherent in staple foods and underscores the significance of embracing dietary variety for comprehensive nutrient intake. Through informed dietary choices, individuals can harness the nutritional potential of both rice and cowpea, fostering a healthier and more nourished society.

Conflict of interest: Authors have declared that there is no conflict of interest reported in this work.

References

[1] Pirman, T., Stibily, V., Stekar, J. M. A. & Combe, E. (2001). Amino Acid Composition of Beans and Lentil. *Zb. Biotech. Fak. Univ. Ljubl., Kmet. Zootech,* 78(1), 57 – 68. htt://www.Bfro.uni-ly.sio/zoo/publikacije/zbornik/

[2] Muranaka, S. Shono, M., Myoda, T., Takeuchi, J., Franco, J., Nakazawa, Y. & Takagi, H. (2016). Genetic diversity of physical, nutritional and functional properties of cowpea grain and relationships among the traits. *Plant Genetic Resources*, 14, 67-76. https://doi.org/:10.1017/S14792611500009X

[3] Minussi, R.C., Rossi, M. Bologna, L. Cordi, L. Rotilio, D. & Pastore, G. M. (2003). Phenolic compounds and total antioxidant potential of commercial wines. *Food Chem.*, 82, 409-416. https://doi.org/10.1016/S0308-8146(02)00590-3

[4] FAO (2018). Nutrient sources – composition of feedstuff and fertilizers. Food and Agricultural Organization of the United Nations, Italy www.fao.org.

[5] Lema, M. (2018). Application of biotechnology on rice (*Oryzae sativa*) improvement: Review article. *Modern Concepts & Dev in Agronomy*, 2, 1–8. https://doi.org/10.31031/MCDA.2018.02.000532

[6] Oxford Dictionary of Biochemical and Molecular Biology (2006). Antinutrients. Retrieved from https://www.googlescholar.com/antinutrients

[7] Afiukwa, C. A., Igwenyi, I. O., Ogah, O. & Ugwu, O. O. (2011). Variations in seed phytic and oxalic acid contents among Nigerian cowpea accessions and their relationship with grain yield. *Continental Journal of Food Science and Technology*, 5(2), 40-48. https://www.cabidigitallibrary.org/doi/full/10.5555/20123237729

[8] Pihlanto, A., Mattila, P., Mäkinen, S. & Pajari, A. M. (2017). Bioactivities of alternative protein sources and their potential health benefits. *Food and Function*, 8, 3443–3458. https://doi.org/10.1039/C7FO00302A

[9] AOAC (Association of Official Analytical Chemists) (2006). Official Method of Analyst AOAC (W. Horwitz Editor) Eighteenth Edition. Washington DC, AOAC.

[10] Aremu, M. O., Olaofe, O., Basu, S. K., Abdulazeez, G. & Acharya, S. N. (2010). Processed cranberry bean (*Phaseolus coccineus* L.) seed flour for the African diet. *Canadian Journal of Plant Science*, 90(5), 719-728. https://doi.org/10.4141/cjps09149.

[11] Otemuyiwa, I. O., Falade, O. S. & Adewusi, S. R. A. (2018). Effect of various cooking methods on the proximate composition and nutrient contents of different rice varieties grown in Nigeria. *Int. Food Res. J.*, 25(2), 747-754. chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/http://www.ifrj.upm.edu.my/25%20(02)%202018/(42).pdf

[12] Oko, A. O. & Onyekwere, S. C. (2010). Studies on the proximate chemical composition and mineral element contents of five new lowland rice varieties in Ebonyi State. *Int. J. Biotechnol. Biochem.*, 6(6), 949–95. https://www.researchgate.net/publication/312469845_Studies_on_the_proximate_chemical_composition_and_mineral_element_contents_of_five_new_lowland_rice_varieties_planted_in_Ibonyi_state

[13] Oyewole, A. C. (2007). Effect of cooking and soaking on physical characteristics, nutrient composition and sensory evaluation of indigenous and foreign rice varieties in Nigeria. *Nig. Afr. J. Biotech.*, 6(8), 1016-1020. https://www.ajol.info/index.php/ajb/article/view/57040

[14] Fari, M. J. M., Rajapaksa, D. & Ranaweera, K. K. D. S. (2011). Quality characteristics of noodles made from selected varieties of Sri Lankan rice with different physicochemical characteristics. *J. Nat. Sci. Found. Sri Lanka*, 39(1), 53–60. https://doi.org/10.4038/jnsfsr.v39i1.2923.

[15] Rohman, A., Helmiyati, S., Hapsari, M., LarasatiSetyaningrum, D. (2014). Rice in health and nutrition. *Int. Food S. J.*, 21(1), 13–24. chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/http://www.ifrj.upm.edu.my/21%20(01)%202014/2%20IFRJ%2021%20(01)%202014%20Rohman%20430.pdf

[16] Olaofe, O., Aremu, M. O. & Okiribiti, B. Y. (2008). Chemical evaluation of the nutritive value of smooth luffa (Luffa cylindrica) seeds kernel. Electronic Journal of Environmental and Agricultural Food Chemistry, 7(10), 3444 – 3452. https://www.researchgate.net/publication/287463656_Chemical_evaluation_of_the_nutritive_value_of_smooth_luffa_Luffa_Cylindrica_seed's_kernel

[17] Aremu, M. O., Bamidele, T. O., Nweze, C. C. & Idris, I. M. (2012). Chemical evaluation of pride of barbados (Caesalpinia pulcherrima) seeds grown in Gudi, Nasarawa State, Nigeria. *Int. J. Chem. Sci.*, 5(1), 29 – 34. https://www.researchgate.net/publication/316646307_Chemical_evaluation_of_pride_of_Barbados_Caesalpina_pulcherrima_seeds_grown_in_Gudi_Nasarawa_State_Nigeria

[18] Siddhuraju, P., Vijayakumari, K. & Janardhanan, K. (1996). Chemical composition and protein quality of the little–known legume, velvet bean (Mucuna pruriens L.). *J. Agric Food Chem.*, 44, 2636–2641. https://doi.org/10.1021/jf950776x

[19] Audu, S. S. & Aremu, M. O. (2011). Nutritional composition of raw and processed pinto bean (*Phaseolus vulgaris* L.) grown in Nigeria. *J. Food, Agric. & Environ.*, 9(3&4), 72–80. https://hero.epa.gov/hero/index.cfm/reference/details/reference_id/4674523

[20] Aremu, M. O., Olaofe, O. & Akintayo, E. T. (2006). Compositional evaluation of cowpea (*Vigna unguiculata*) varieties and scarlet runner bean (*Phaseolus coccineus*) varieties flour. *J. Food, Agric. & Environ.*, 4(2), 39–43. https://www.researchgate.net/publication/265888264_Compositional_evaluation_of_cowpea_Vigna_unguiculata_and_scarlet_runner_bean_Phaseolus_coccineus_varieties_grown_in_Nigeria

[21] Ogunlade, I., Olaofe, O. & Fadare, T. (2005). Chemical composition, amino acid and functional properties of *Leucaena leucocepha* seeds flour. *Nigeria J. Appl. Sci.*, 21, 7–12. https://www.cabidigitallibrary.org/doi/full/10.5555/20053097366

[22] Nieman, D. C., Butterworth, D. E. & Nieman, C. N. (1992). Nutrition. Wm. C. Brown Publishers, Dubuque, I. A. 540p. https://www.sciepub.com/reference/51349

[23] Aremu, M. O., Andrew, C., Oko, O. J., Odoh, R., Zando, C., Usman A. & Akpomie, T. (2022). Comparative studies on the physicochemical characteristics and lipid contents of desert date (*Balanites aegyptiaca* (L.) Del) kernel and pulp oils. *European Journal of Nutrition & Food Safety*, 14(1), 20–30. https://doi.org/10.9734/ejnfs/2022/v14i130473

[24] Robinson, D. E. (1987). Food Biochemistry and Nutritional Value. Longman Scientific and Technology, Burnmell, Haslow, England, pp. 327 – 328. https://www.sciepub.com/reference/140488

[25] FAO (1970). List of Foods Used in Agriculture, Nutritional Information Document Series Number 2, Food and Agriculture Organization of the United Nations, Rome, Italy, p. 45.

[26] Audu, S. S., Aremu, M. O. & Lajide, L. (2013). Effects of processing on physicochemical and antinutritional properties of black turtle bean (*Phaseolus vulgaris* L.) seeds flour. *Oriental J. Chem.*, 29(3), 979 – 989. http://dx.doi.org/10.13005/ojc/290318

[27] Adesina, A. J. & Adeyeye, E. I. (2012). The proximate and mineral composition of fatted and defatted marble vine seeds. Proceedings of the 36th Annual Conference of NIFST, 15–19 October, EKO 2012, 225–226. https://www.researchgate.net/publication/278613038_The_proximate_and_mineral_composition_of_fatted_and_defatted_Marble_Vine_seed

[28] Coe, F.L., Evan, A. & Worcester, E. (2005). Kidney stone disease. *J. Clin. Invest*, 115(10), 2598 – 2608. https://doi.org/10.1172/JCI26662

[29] Soetan, K. O. & Oyewole, O. E. (2009). The need for adequate processing to reduce the antinutritional factors in plants used as human foods and animal feeds: A review. *African Journal of Food Science*, 3(9), 223-232. https://www.cabidigitallibrary.org/doi/full/10.5555/20103303602

[30] Singh, B., Singh, J. P., Singh, N. & Kaur, A. (2017). Saponins in pulses and their health promoting activities: A review. *Food Chemistry*, 233, 540–549. https://doi.org/10.1016/j.foodchem.2017.04.161

[31] Parikh, M., Netticadan, T. & Pierce, G. N. (2018). Flaxseed: Its bioactive components and their cardiovascular benefits. *Amer. J. of Physiol., Heart & Circulatory Physiol.*, 313, 146–159. https://doi.org/10.1152/ajpheart.00400.2017

[32] Aremu, M. O., Ibrahim, H. & Ekanem, B. E. (2016). Effect of processing on in–vitro protein digestibility and anti– nutritional properties of three underutilized legumes grown in Nigeria. *British Biotechnology Journal*, 14(1), 1 – 10. https://doi.org/10.9734/BBJ/2016/22581

[33] Ijeomah, A. U., Ugwuona, F. U. & Ibrahim, Y. (2012). Nutrient composition of three commonly consumed indigenous vegetables of north-central Nigeria. *Nig. J. of Agric., Food and Env.*, 8(1), 17 – 21.

[34] Aliyu, S. B., Aremu, M. O., Onwuka, J. C. & Passali, D. B. (2023). Nutritive and antinutritive values of fermented guinea corn (*Sorghum bicolor* L.) fortified with bambara groundnut (*Vigna subterranea* L.) flour. *Lafia J. of Scientific and Ind. Res.*, 1(2), 15–21. https://doi.org/10.62050/ljsir.2023.v1n2.268

[35] Silva, E. O. & Bracarense, A. P. (2016). Phytic acid: From antinutritional to multiple protection factor of organic systems. *Journal of Food Science*, 81, 1357–1362. https://doi.org/10.1111/1750-3841.13320

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