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# RESPONSE IN QUALITY TRAITS OF *OGIRI* TO PARTIAL SUBSTITUTION OF CASTOR OIL BEAN SEEDS (*Ricinus communis*) WITH MELON SEEDS (*Citrillus vulgaris*)

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## Abstract
Indigenous condiment like *ogiri* is used by many ethnic groups to improve the flavour and acceptability of many foods. They are particularly produced by fermenting leguminous crops with the major intent of adding flavour to foods. Castor oil bean seeds are scarce and expensive alongside the controversy on cancer inducing property of monosodium glutamate. This study tends to investigate the impact of melon seed partial substitution on the quality traits of "ogiri" produced from their blends. Proximate, mineral and vitamin composition and sensory characteristics were evaluated using standard methods. Proximate analysis revealed increase in crude protein (17.33%-28.12%), crude fibre (0.47-1.94%) and fat content (13.76-23.19%), while ash content (3.71-3.26%) and carbohydrate content (48.13%-23.55%) decreased with increasing level of melon seeds substitution. Mineral contents increased with increasing level of melon seeds with values ranging from 46.11-80.61 mg/100g, 60.25-74.24 mg/100g, 80.33-101.23 mg/100g, 1.63-8.66 mg/100g, 0.49-1.81 mg/100g for calcium, magnesium, phosphorous, iron and zinc respectively. Potassium decreased from 860.12 to 137.11 mg/100g with increased melon seed substitution. The vitamin composition which comprised of retinol (11.63-16.03 mg/100g), vitamin $B_1$ (0.10-0.19 mg/100g), vitamin $B_2$ (10.37-14.26 mg/100g), vitamin $B_3$ (9.21-9.66 mg/100g), vitamin C (2.43-5.01 mg/100g) and vitamin E (6.43-12.11 mg/100g) increased with increasing level of melon seeds inclusion. Sensory analysis increased with increase in melon seed substitution, but ogiri sample produced from 100% castor oil bean seeds had the best organoleptic properties (6.00). This study has demonstrated the production potential, nutrition and health benefits of melon seed inclusion in ogiri production.

**Keywords: *Ogiri*, quality traits, melon seed, and castor oil bean**

## Introduction
Seasonings, such as condiments, herbs and spices are food ingredients particularly used for food flavouring. There are over 2,000 known food seasonings in Africa, and most of them are derived from plants, and valued for their bulking effects, while others may be used for garnishing or spicing foods (Chukwu *et al.,* 2010). Among the two types of seasonings; fermented food seasonings or local seasonings are those food seasonings which undergo traditional food processing methods that involves biochemical changes brought about by microbes inherent in grain or derived from a starter culture and their enzymes (Sanni *et al.,* 2002; Achi, 2005). Traditional fermented seasonings used in Nigeria include: African oil bean (*Pentadethra macrophylla*) ogiri, (a fermented melon, soybean, or African yam bean paste), African locust bean (Dawadawa), and Okpeye (*Prosopis africana*) (Achi, 2013). Traditional preparation of Ogiri from selected legumes (melon seed, soya bean, African yam bean) is by the method of uncontrolled solid-state fermentation (Achi, 2005) and it involves boiling the raw seeds after which they are de-hulled, and then boiled again to soften seeds for fermentation. The softened seeds are wrapped in leaves, and incubated near fire source in the kitchen for a period of three to five days or longer, followed by pounding in mortar and pestle into paste called ogiri. The paste is finally wrapped in leaves. Ogiri have rich chemical composition which makes them an excellent source of biological active substance for micro-organisms.

Melon seeds (*C. vulgaris*) have generally greyish white hard shells with a white inner kernel or seed, which is soft and oval in shape. The seed has low carbohydrate content including glucose, fructose from 4.6 to 16.0%, 18.0% sucrose, starch up to 4.5% pectin, vitamins A, C, D, K, B, and E, folic acid, carotene, minerals

(Potassium, Calcium, Phosphorus etc.), rich in glycosides oil (30.0 to 50.0), high protein (12.0 to 35.0%) and various aromatic compounds. The seeds are also rich in omega-3-fatty acids, vitamins, fats, other nutrients (Azhari *et al.,* 2014), high amounts of antioxidants, and are viewed as an excellent source of folic acids, calcium, magnesium, zinc and protein (Chukwu *et al.,* 2018). Proximate composition revealed that melon seeds consist of about 50% oil by weight, 37.4% protein, 2.6% fibre, 3.6% ash and 6.4% moisture. Oil content of the seed contains 50% of unsaturated fatty acids, which are linoleic (35%) and oleic (15%) and 50% saturated fatty acids, which are stearic and palmitic acids (David and Aderibigbe, 2010). The presence of unsaturated fatty acids makes melon seeds nutritionally desirable and suggests a possible effect in lowering of blood cholesterol. The consumption of melon seeds and its product reduces the chances of developing heart diseases. Melon has an amino acid profile that compares favourably with that of soybean and even white albumen of eggs. Melon seeds can be used as an important supplement in baby food, as it helps to prevent malnutrition. In West African region where soups are integral to life, they are major soup ingredient and common component of daily meals (Barber and Achinewhu, 1992). When coarsely ground, they thicken stews and contribute to widely enjoyed steamed dumplings. Some melon seeds are soaked, fermented, boiled and wrapped in leaves to form a favourite food seasoning (Ogunbusola *et al.,* 2012).

Castor oil bean (*Ricinus communis*) is a member of the genius Ricinus and a native of tropical Africa, cultivated in several varieties for the oil in its leaves and for its bold foliage (Sims and Frey, 2005). Castor oil plant though indigenous to the South-East Mediterranean region and parts of East Africa is today widespread throughout the tropical regions of the world (Ibe and Orabuike, 2009). Mature green seed capsule clusters when harvested are spread on the ground to dry, split open and the seeds falls out (Chukwu *et al.,* 2010). The seeds are a good source of castor oil, which are of medicinal and industrial uses (Sims and Frey, 2005). They contain between 40% and 60% oil that is rich in triglycerides, mainly ricinolein and ricin, which are water-soluble toxin but present in lower concentrations throughout the plant. Ricin is eliminated by fermentation (Odunfa, 1985). Castor oil bean seed consists of about 9.1 to 20.5% soluble carbohydrate, 21 to 48% protein, 1.9 to 50% crude fat, 5 to 12% moisture, 2.5 to 24.5% crude fibre, 8.1 to 19.2% total ash, 1.06 to 5.67% calcium and 0.3 to 0.73% phosphorus (Annongu *et al.,* 2008). The use of castor oil bean seed in ogiri production has been increasingly investigated. Scarcity of the seeds and recent series of controversial publications and debates over the use of industrial seasonings like magi and monosodium glutamate as a cancer inducing seasoning (Nnanyelugo, 1996) in Nigeria have prompted substitution with readily available melon seeds. This present study therefore, seeks to evaluate effect of melon seed substitution on the quality characteristics of ogiri produced from castor oil bean.

## Materials and Methods

***Source of raw materials***

The melon seeds (Plate 1) and castor oil bean seeds (Plates 2) used in this research were purchased from Nsukka market, in Enugu State, Nigeria.

**Plate 1: melon seeds**

**Plate 2: castor oil bean seeds**

***Sample preparation***

***a. Preparation of "ogiri" from castor bean seeds.***

The method described by Ibe and Orabuike (2009) was used in the preparation of ogiri samples as shown in Figure 1. De-hulled castor oil bean seeds were wrapped in banana leaves, boiled for 2 hrs, strained and boiled again for 6 hrs. The seeds were pounded into soft paste in a clean mortar into pestle, wrapped with banana leaves and allowed to ferment for 5 days at room temperature (29°C). The fermented pastes were placed near a heat source for 48 hrs to achieve maximum fermentation and flavour development.

***b. Production of "ogiri" from melon and castor oil bean seed blends***

The production flow chart of ogiri from melon and castor oil bean seeds blends is represented in Figure 2. De-hulled castor oil bean and melon seeds were blended (Table 1) and used to prepared three ogiri samples.

**Table 1: Sample codes with their formulation blends used for ogiri production**

| Sample codes | CBS (%) | MS (%) |
|---|---|---|
| CBS100: MS0 | 100 | 0 |
| CBS95: MS5 | 95 | 5 |
| CBS90: MS10 | 90 | 10 |
| CBS50: MS50 | 50 | 50 |

**CBS = Castor oil bean seed. MS = Melon seed**

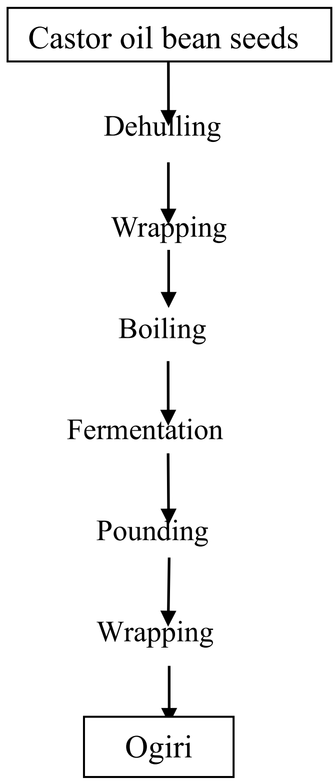


**Fig 1: Flow chart production of ogiri from Castor oil bean seed**

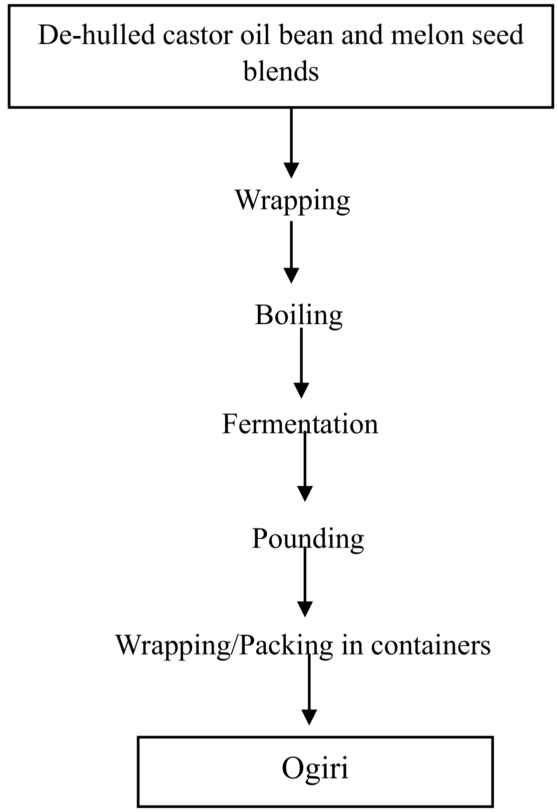


**Figure 2: Production of ogiri from castor oil bean and melon seed blends**

***Analysis***

***a. Proximate analysis***

The method described by AOAC (2000) was used in evaluating the moisture, crude fibre, protein, fat, and ash content, while the carbohydrate content was determined by difference.

***b. Vitamin analysis***

Retinol, vitamin $B_1$, vitamin B2, vitamin B3, and ascorbic acid were determined using the method described by Rutkowski (2010).

***c. Mineral analysis***

The method described by Carpenter and Hendricks (2003) was used in determining the calcium, magnesium, potassium, sodium and phosphorous contents of ogiri samples.

***d. Dietary energy content***

This was calculated by Atwater factor using the energy substrates (Mullan, 2006).

***Sensory evaluation***

Sensory Evaluation was carried out according to the method described by Iwe (2010) on each of the samples using 20 semi-trained panellists to assess the sensory attributes (appearance, aroma, texture, and overall acceptability) of the samples. The panellists were selected randomly cutting across students of the university community which include mostly people who consume ogiri. The samples were presented in coded identical plates with water to rinse their mouth after each tasting. The panellists were instructed to rate the sample for the attributes based on a 9-point Hedonic scale ranging from 9-liked extremely to 1-disliked extremely.

***Statistical analysis***

The experimental design used in this study was a completely randomized design (CRD) and the data was subjected to analysis of variance (ANOVA) at 0.05% level of significance to determine significance difference. The SPSS package (version 22.0) was used for statistical analysis, while treatments mean was separated using Duncan multiple range test at (0.05) significant level.

**Results and Discussion**

The results of the proximate composition are presented in Table 2.

***Moisture content***

Moisture content (MC) of the ogiri samples ranged from 16.84 to 20.03%. There was a significant ($p<0.05$) moisture content decrease (20.03 to 10.03%) with increase in melon seed substitution, which could be attributed to the hydrolytic decomposition product of protein during fermentation (Enujiugha, 2009). This trend may imply that melon seeds may have contributed some protein which amino acids may have bound and held the free water (Sanful and Darko, 2010). Higher moisture content of castor oil bean-melon seeds ogiri samples may mean better shelf stability compared to the control sample (Okaka and Okaka, 2001) as they will take longer time to dry out and lose their flavour. The results obtained in this study are lower than the values (39.70 to 50.84%) reported by Ukegbu (2016) and 27.00 -31.00% reported by Ishiwu and Tope (2015), which could be attributed to moisture and protein content of the raw materials and preparatory methods used, specifically the extent and procedure of fermentation.

***Crude protein***

Crude protein content of the samples increased from 17.33% (control) to 28.12 %. (50:50 blend) with increase in melon seed substitution as evident in the higher protein content of 20.15%, 23.68% and 28.12% than control, due to respective melon seed substitution levels of 5%, 10% and 50%. This development could be attributed to the high protein content nature of melon seed. Ishiwu and Tope (2015) also reported that crude protein content increases during fermentation process. Thus, the increase in protein content of the samples could be related to the fermentation process as a result of the activities of predominant proteolytic micro-organisms that hydrolysed the product to different free amino acids (Enujiugha, 2009). High protein content of the product is noteworthy since it could contribute to dietary protein in addition to its flavouring role. Protein complements body's need for essential nutrients for growth and development, repair of worn out tissues, provide energy and is essential for human survival (Voet *et al*., 2008).

***Crude fibre***

Crude fibre content of the samples increased significantly ($p<0.05$) from 0.47 in the control to 1.94% in 50:50 blend with increasing melon seed substitution, which is in line with the report of Ugwuarua (2010). Fibre has been reported to offer a variety of health benefits and is essential in reducing the risk of chronic disease such as diabetes, obesity, cardiovascular disease and diverticulitis. It acts to lower the concentration of low density lipoprotein cholesterol in the blood, possibly by binding with bile's acids (Ishiwu and Tope, 2015). The results obtained in this study implied that the crude fibre content of ogiri can be increased with the addition of melon seed. The results differed from 2.59%-7.50% reported by Ukegbu (2016).

***Fat***

Fat content ranged from 13.76% to 23.19%, with the control sample having the lowest fat content (13.76%), while the 50:50 blend had the highest (23.76%). The fat content (13.76%) of the control sample (100% castor oil bean seed) was slightly higher than 13.6% reported by Ugwuarua (2010) on castor oil bean seed. Fat provides energy, absorbs certain nutrients and maintain body temperature. Increasing additions of melon seed at 5%, 10% and 50% resulted to an increase in fat content by 15.92%, 17.88%, and 23.19% respectively in the ogiri samples. The increase in the fat content due to fermentation may be associated with the increased activity of lipolytic microorganisms. The improved lipid content of the samples is of nutritional significance considering the high calorific value of lipids. Thus, the studied samples could possibly serve as a source of essential fatty acids and fat soluble vitamins.

***Ash***

Ash content was least (3.26%) in the 50:50 blend and highest (3.71%) in 95:5 blend which indicated significant ($p<0.05$) decrease in ash content with increased melon seed substitution. This may mean that the castor oil bean seed has more mineral than the melon seeds. Therefore, addition of melon seed at lower amount increased the ash content of the samples which translates to improved mineral content. These results are higher than the values (2.98 to 3.47%) reported by Ishiwu and Tope (2015). Ash content represents the total minerals content in foods and thus, serves as a viable tool for nutritional evaluation of mineral (Lienel, 2002).

***Carbohydrate***

Carbohydrate content of the ogiri samples decreased significantly ($p<0.05$) from 48.13% in the control to 23.55% in 50:50 blend with increasing level of melon seed addition. These results are in agreement with those obtained by Sanful and Darko (2010), Aly *et al*. (2012) and Ishiwu and Tope (2015). They established that complementation with oil seed such as melon seed at different levels led to a decrease in carbohydrate content.

***Mineral composition***

Results of mineral composition are shown in Table 3.

***Calcium***

Calcium content of the samples increased significantly ($p<0.05$) from 46.11 mg/100g in sample CBS100:MS0 to 89.61 mg/100g in CBS50:MS50, but lower in comparison to the values (125.44 to 345.65 mg/100g) reported by Ukaegbu (2016), probably due to type and processing methods. Addition of melon seed at 5%, 10% and 50% was observed to increase the calcium content of the samples to 62.91mg/100g, 64.17mg/100g and 89.61mg/100g respectively from 46.11mg/100g in control sample (CBS100:MS0). This is important since calcium in the body helps in the building and maintenance of bones, teeth and plays a key role in nerve transmission and muscle function, necessary for blood clotting, and aids conversion of food into energy (Fallon and Enig, 2007).

***Sodium***

No significant ($p<0.05$) difference was recorded in the sodium content of the samples when castor oil bean seed was substituted with melon seed at 5% (200.61 mg/100g) and 10% (200.53 mg/100g). This may mean that variation in sodium contribution between the two levels were not significant ($p>0.05$). However, increasing melon seed proportion to 50% resulted to an increased sodium content of 411.06 mg/100g compared to the control sample (147.22 mg/100g). Thus, increasing the proportion of melon seed would possibly provide more beneficial effect of sodium that is critical to the function of the nervous system, and to muscular contraction, and nerve end signals conducted through movement of positive charged sodium particles. Sodium also helps to maintain fluid balance in the body (Lienal, 2002).

***Magnesium***

Similar to calcium content, magnesium content of the samples increased with significant (p<0.05) difference from 68.13mg/100g to 74.24mg/100g as the level of melon seed substitution increased from 5% to 50%. This increasing magnesium result trends indicated that ogiri and other food material could be enriched with magnesium through the addition of melon seeds. Magnesium synergizes with Phosphorus to build strong bones and teeth. Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation (Aydin *et al.,* 2010: Base line of Health, 2019). Magnesium is required for energy production, phosphorylation, glycolysis, contributes to the structural development of bone, required for the synthesis of DNA, RNA and the antioxidant glutathione (Soetan *et al*., 2010).

***Phosphorous***

Values of phosphorous obtained in this study ranged from 80.33 mg/100g in CBS100: MS0 to 101.23 mg/100g in CBS50: MS50. These results revealed the increasing impact of melon seed incorporation on the phosphorous content of ogiri as evident in sample CBS50: MS50 with highest phosphorus content (101.23mg/100g). There was significant (p<0/05) phosphorous difference between all the samples. Phosphorous works in synergy with calcium to form calcium phosphate which is the predominant mineral of bone.

***Potassium***

This is the most abundant mineral recorded in the ogiri samples which decreased from 860.12 mg/100g in sample CBS95:MS5 to 137.11 mg/100g in sample CBS50:MS50, lower than control sample (641.02 mg/100g). The results obtained in this study signified that the studied samples at low level of melon seed substitution; not exceeding 10% would be a good source of potassium which is a very important mineral for the proper functioning of all cells, tissues, and organs in the human body. Potassium is also an electrolyte, a substance that conducts electricity in the body, along with sodium, calcium and magnesium. It plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function (Organic Facts, 2018).

***Iron***

Dietary iron is the second to the least mineral content of ogiri samples which increased with significant (p<0.05) variations from 1.63 mg/100g in sample CBS100:MS0 to 8.60 mg/100g in sample CBS50:MS50**.** Therefore, increased melon seed substitution results in significant iron improvement. Iron helps the red blood cells transport oxygen to all parts of the body and plays an important role in specific processes within the cell that produce the energy for our body (ODS, 2007).

***Zinc***

Zinc content of ogiri was the least mineral content that recorded highest value (1.81 mg/100g) in sample CBS50:MS50 and lowest (0.49 mg/100g) in CBS100:MS0. There was significant (p<0.05) zinc variations between the samples which increased with increasing melon seed substitution. Zinc is needed for the body's defensive (immune) system to work properly (Bastin, 1996). It plays a role in cell division, cell growth, wound healing and the breakdown of carbohydrates (Singh *et al*., 2011).

**Vitamin composition**

The results are presented in Table 4.

***Retinol***

Retinol content of the ogiri samples increased with increase in melon seed substitution from 11.63 mg/100g in the control (CBS100: MS0) to 16.03mg/100g in (CBS100:MS0) to 16.03mg/100g in sample CBS50:MS50. At 5%, 10% and 50% melon seed substitution, the retinol content of the ogiri samples increased to 12.59 mg/100g, 12.62 mg/100g and 16.03 mg/100g respectively from 11.63mg/100g (control), which apparently indicated that melon seed could possibly contain significant (p<0.05) amount of vitamin A (Omafuvbe *et al.,* 2003). There were significant differences (p<0.05) between all the samples except for samples CBS95:MS5 and CBS90:MS10 which were similar. Retinol is a pre-cursor of vitamin A which is a fat-soluble vitamin and a powerful antioxidant. It plays a critical role in maintaining healthy vision, neurological function, healthy skin and support immune function. It is involved in reducing inflammation through fighting free radical damage (Bradford, 2015).

***Vitamin $B_1$***

Vitamin $B_1$ increased from 0.10 mg/100g in sample CBS95: MS5 to 0.19 mg/100g in CBS50: MS50 with significant (p<0.05) difference. Addition of melon seed at 5% and 10% resulted to lower vitamin $B_1$ compared to the control sample (0.17 mg/100g) but higher vitamin $B_1$ was recorded when the level of melon seed substitution was increased to 50% (0.19 mg/100g). This implied that melon seed may have contained more vitamin $B_1$ than castor oil bean seeds and could improve the vitamin $B_1$ of ogiri when added above 10%.

***Vitamin $B_2$***

Vitamin $B_2$ increased significantly (p<0.05) with increase in melon seed substitution from 11.26 mg/100g in sample CBS95: MS5 to 14.26 mg/100g in CBS50: MS50 higher than the control (10.37 mg/100g) which is an improvement. Higher vitamin $B_2$ content in CBS50:MS50 sample could be attributed to the increase in melon seed inclusion which is a good source of B-complex vitamin (Ogunbusola *et al.,* 2012) required for normal growth, proper functioning of heart and nervous system, formation of co-enzyme for cellular respiration (Everyday Health, 2018).

***Vitamin $B_3$***

Like other B-complex vitamin, vitamin $B_3$also increased with melon seed substitution from 9.24 mg/100g in sample CBS95: MS5 to 9.66mg/100g in CBS50: MS50. All the increase due to melon seed inclusion were higher than the control value (9.21 mg/100g) which still prefigured melon seed a better vitamin $B_3$ source than castor oil bean seeds. All the samples were significantly ($p<0.05$) different from each other except control and CBS95: MS5 samples which are similar.

***Vitamin C***

Vitamin C content ranged from 2.43 mg/100g to 5.01 mg/100g with the control sample having the lowest value, while sample CBS50:MS50 had the highest. Notably, the inclusion of melon seed was observed to increase the vitamin C content of the ogiri samples which is beneficial in bone and joint development, purifies the blood, act as antioxidant (Cohen *et al.,* 2000).

***Vitamin E***

Vitamin E content of the samples was found to increase with increasing level of melon seed substitution as evident in lower value (6.43 mg/100g,) of the control sample compared to those from 5% (7.81 mg/100g), 10% (8.32 mg/100g) and 50% (12.11 mg/100g) levels of substitution. Vitamin E is a strong antioxidant that potentially prevents damage caused by free radicals which can modify components of the cell such as proteins, DNA and lipids. Vitamin E has been shown to prevent oxidation of low-density lipoprotein cholesterol in vascular cells (Skyrme and Jones, 2000). Thus, the vitamin may play a role in the prevention of atherosclerotic cardiovascular diseases and cancer, critical in maintaining cellular functionality in general, may inhibit cell proliferation, and enhance immune function (Meydani *et al.,* 2005). Thus, the results obtained in this study revealed that the studied samples may be a viable transport of important vitamins that are capable of fighting free radicals in the human body.

***Dietary energy***

Dietary energy profiles of the samples as presented in Table 5 showed significant ($p<0.05$) decrease (370.52 to 362.32Kcal/g) with melon seed substitution lower than the control (371.56Kcal/g). This could stem from higher carbohydrate value which is a good energy substrate. The energy value of CBS50:MS50 which came second could be traced to increased protein, fat and fibre during fermentation. Significant ($P<0.05$) energy variations between all samples may signify significant ($P<0.05$) variations in energy contribution by different seed blends. Despite the energy variations, all the samples were good energy sources. Dietary energy is needed in the body for metabolic processes, physiological functions, muscular activity, heat production, growth, transport of substances around the body, synthesis of enzymes and hormones (NHMRC, 2016).

**Sensory characteristics**

The results of sensory characteristics are presented in Table 6. The appearance scores of the samples ranged from 4.70 to 6.55. The appearance mean score samples containing 5% (CBS95:MS5) (5.30) and 10% (CBS90:MS10) (4.70) melon seed had lower scores compared to the control sample (6.20), which suggest that the appearance of both samples was less preferred to the control. However, the appearance of samples containing 50% melon seed (CBS50:MS50) with a mean score of 6.55 was most preferred by the panellists. The aroma scores were found to be highest in the control sample (5.60) which was not significantly ($p<0.05$) different from ogiri sample containing 50% melon seed (5.55) as rated by the panellists. Similar to appearance scores, the scores for 5% (4.00) and 10% (5.10) were lower compared to the control samples (5.60). Notably, the aroma scores of the castor oil bean-melon ogiri samples improved with increasing level of melon seed inclusion. The significant improvement in aroma observed in CBS50:MS50 could be attributed to the increased melon seed substrate available for microbial utilization, leading to the release of increased aromatic substances by the fermenting organisms (Ouoba *et al.,* 2005). The scores for texture ranged from 4.35 – 5.85. The control samples (5.85) was rated higher in terms of texture above ogiri samples containing 5% (4.35), 10% (4.80) and 50% (5.50) melon seed. The scores for general acceptability showed that the inclusion of 50% melon seed in the production of ogiri from castor oil bean was most preferred among the three levels of substitution with a mean score of 5.75; however, ogiri produced from 100% castor oil bean was best preferred among the samples (6.00) studied. Generally, it could be inferred that ogiri produced from 100% castor oil bean seed had the most preferred organoleptic properties with respect to aroma, texture and general acceptability as rated by the panelists.

**Conclusion**

Increase in melon seed substitution increased crude protein, crude fibre, and fat content of the ogiri samples, while the ash and carbohydrate contents decreased. All the minerals evaluated increased with increasing level of melon seed substitution, except in potassium which was the most abundant and highest at low level of melon seed substitution not exceeding 10%. Furthermore, all the vitamins evaluated increased beyond the control, while the acceptability improved below the control (100% castor oil bean seed ogiri) with increasing level of melon inclusion. Despite the energy value decrease with increase in melon seed, all the ogiri samples proved to be good sources of energy. This study has therefore validated the production potential, nutrient improvement and health benefits of melon seed inclusion in ogiri production.

**Table 2: Proximate composition of ogiri produced from Castor oil bean seeds and Melon seeds blends (%)**

| Sample | Moisture | Crude Protein | Crude Fibre | Fat | Ash | Carbohydrate |
|---|---|---|---|---|---|---|
| CBS100: MS0 | $16.84^{d}\pm0.03$ | $17.33^{d}\pm0.01$ | $0.47^{d}\pm0.01$ | $13.76^{d}\pm0.01$ | $3.48^{c}\pm0.01$ | $48.13^{a}\pm0.00$ |
| CBS95: MS5 | $20.03^{a}\pm0.02$ | $20.15^{c}\pm0.01$ | $1.08^{c}\pm0.01$ | $15.92^{c}\pm0.01$ | $3.71^{a}\pm0.01$ | $40.12^{b}\pm0.03$ |
| CBS90: MS10 | $19.95^{b}\pm0.02$ | $23.68^{b}\pm0.01$ | $1.26^{b}\pm0.01$ | $17.88^{b}\pm0.01$ | $3.59^{b}\pm0.01$ | $33.58^{c}\pm0.01$ |
| CBS50: MS50 | $19.03^{c}\pm0.02$ | $28.12^{a}\pm0.01$ | $1.94^{a}\pm0.01$ | $23.19^{a}\pm0.01$ | $3.26^{d}\pm0.01$ | $23.55^{d}\pm0.01$ |

**CBS100: MS0 is 100% castor oil bean seed ogiri, CBS95: MS5 is 95: 5 blend ogiri, CBS90: MS10 is 90: 10 blend ogiri and CBS50:MS50 is 50: 50 blend ogiri. Values with same superscript a-d within the same column are not significantly different (P>0.05)**

**Table 3: Mineral composition of ogiri produced from castor oil bean seeds and melon seed blends (mg/100 g)**

| Sample | Calcium | Sodium | Magnesium | Phosphorus | Potassium | Iron | Zinc |
|---|---|---|---|---|---|---|---|
| CBS100: MS0 | $46.11^{d}\pm0.01$ | $147.22^{c}\pm0.01$ | $60.25^{d}\pm0.01$ | $80.33^{d}\pm0.01$ | $641.02^{c}\pm0.01$ | $1.63^{d}\pm0.01$ | $0.49^{d}\pm0.01$ |
| CBS95: MS5 | $62.91^{c}\pm0.01$ | $200.53^{b}\pm0.72$ | $68.13^{c}\pm0.01$ | $84.97^{c}\pm0.01$ | $860.12^{a}\pm0.02$ | $2.37^{c}\pm0.01$ | $0.72^{c}\pm0.01$ |
| CBS90: MS10 | $64.17^{b}\pm0.01$ | $200.61^{b}\pm0.01$ | $69.33^{b}\pm0.01$ | $87.41^{b}\pm0.01$ | $822.12^{b}\pm0.00$ | $2.46^{b}\pm0.02$ | $0.82^{b}\pm0.01$ |
| CBS50: MS50 | $89.61^{a}\pm0.01$ | $411.06^{a}\pm0.01$ | $74.24^{a}\pm0.01$ | $101.23^{a}\pm0.01$ | $137.11^{d}\pm0.01$ | $8.66^{a}\pm0.02$ | $1.81^{a}\pm0.01$ |

**CBS100:MS0 is 100% castor oil bean seed ogiri, CBS5:MS95 is 95:5 ogiri, CBS90:MS10 is 90:10 ogiri and CBS50:MS50 is 50:50 ogiri. Values with same superscript a-d: same superscript within the same column are not significantly different (P>0.05)**

**Table 4: Vitamin content of Ogiri produced from castor oil bean seeds and melon seeds blends (mg/100 g)**

| Sample | Retinol (IU) | Vitamin $B_1$ | Vitamin $B_2$ | Vitamin $B_3$ | Vitamin C | Vitamin E |
|---|---|---|---|---|---|---|
| CBS100: MS0 | $11.63^{c}\pm0.01$ | $0.17^{b}\pm0.01$ | $10.37^{c}\pm0.01$ | $9.21^{c}\pm0.01$ | $2.43^{d}\pm0.01$ | $6.43^{d}\pm0.02$ |
| CBS95: MS5 | $12.59^{b}\pm0.01$ | $0.10^{d}\pm0.00$ | $1.26^{b}\pm0.01$ | $9.24^{c}\pm0.00$ | $3.14^{c}\pm0.01$ | $7.81^{c}\pm0.01$ |
| CBS90: MS10 | $12.62^{b}\pm0.01$ | $0.12^{c}\pm0.01$ | $11.48^{b}\pm0.01$ | $9.31^{b}\pm0.01$ | $3.41^{b}\pm0.01$ | $8.32^{b}\pm0.01$ |
| CBS50: MS50 | $16.03^{a}\pm0.01$ | $0.19^{a}\pm0.01$ | $14.26^{a}\pm0.01$ | $9.66^{a}\pm0.01$ | $5.01^{a}\pm0.01$ | $12.11^{a}\pm0.01$ |

**CBS100: MS0 is 100% castor oil bean seed ogiri, CBS95: MS5 is 95: 5 blend ogiri, CBS90: MS10 is 90:10 blend ogiri and CBS50: MS50 IS 50:50 blend ogiri. Values with same superscript a-d: within the same column are not significantly different (P>0.05)**

**Table 5: Calculated energy profiles of the "ogiri" samples from blends of castor oil bean and melon seeds**

| Samples | Protein | Fat | Crude fiber | CHO | Ev (Kcal/g) |
|---|---|---|---|---|---|
| CBS100:MS0 | $17.33^{d}\pm0.01$ | $13.76^{d}\pm0.01$ | $0.47^{d}\pm0.01$ | $48.13^{a}\pm0.00$ | $371.56^{a}\pm0.01$ |
| CBS95:MS5 | $20.15^{c}\pm0.01$ | $15.92^{c}\pm0.01$ | $1.08^{c}\pm0.01$ | $40.12^{b}\pm0.03$ | $370.52^{b}\pm0.01$ |
| CBS90:MS10 | $23.68^{b}\pm0.01$ | $17.88^{b}\pm0.01$ | $1.26^{b}\pm0.01$ | $33.58^{c}\pm0.01$ | $362.32^{d}\pm0.01$ |
| CBS50:MS50 | $28.12^{a}\pm0.01$ | $23.19^{a}\pm0.01$ | $1.94^{a}\pm0.01$ | $23.55^{d}\pm0.01$ | $367.74^{c}\pm0.01$ |

Energy values are mean duplicate determinations ± standard deviation. Values on same column with different superscript are significantly different ( $P<0.05$). CBS100:MS0 is 100% castor oil bean seed (control), CBS95:MS5=95:5 blend, CBS90:MS10 =90:10 blend and CBS50:MS50 = 50:50 blend. CHO = carbohydrate, Ev = energy value.

**Table 6: Sensory properties of the ogiri produced from castor oil bean and melon seeds**

| Samples | Appearance | Aroma | Texture | General Acceptability |
|---|---|---|---|---|
| CBS100: MS0 | $6.20^{ab} \pm 1.85$ | $5.60^{a} \pm 1.85$ | $5.85^{a} \pm 2.08$ | $6.00^{a} \pm 2.00$ |
| CBS95: MS5 | $4.70^{c} \pm 2.00$ | $4.00^{c} \pm 1.95$ | $4.35^{c} \pm 1.87$ | $4.30^{c} \pm 1.89$ |
| CBS90: MS10 | $5.30^{bc} \pm 2.18$ | $5.10^{b} \pm 1.48$ | $4.80^{bc} \pm 1.51$ | $5.00^{bc} \pm 1.62$ |
| CBS50: MS50 | $6.55^{ab} \pm 1.99$ | $5.55^{a} \pm 2.65$ | $5.50^{ab} \pm 2.31$ | $5.75^{ab} \pm 1.83$ |

a-d: same superscript within the same column are not significantly different (P>0.05)

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