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Influence of drying techniques on the quality characteristics of wheat flour cookies enriched with *moringa* (*Moringa oleifera*) leaf powder

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Abstract
Cookies were produced from wheat flour enriched with *Moringa* leaf powder derived from various drying methods (oven, sun and shade) and fresh leaves prior to milling and used in the formulations to evaluate the quality characteristics which included the physical, chemical and sensory properties of the resultant products. Cookies from 100% wheat flour were equally produced and used as the control sample. The results showed no significant differences in height of all the cookie samples with 10% *Moringa* leaf enrichment. Oven dried *Moringa* leaves showed the least height (0.65cm), greater diameter (4.01cm) and spread ratio (6.33). All *Moringa* enriched cookies had significantly lower ($p<0.05$) ash and fat contents than the control sample with ash and fat content of (2.06% and 20.32%), respectively. The protein content of the oven dried sample was significantly higher (10.43%) with 10% *Moringa* leaves powder enrichment compared to cookies produced with egg and milk devoid of *Moringa* leaf powder with protein content of (10.03%). Cookies produced with *Moringa* enrichment had significantly ($p>0.05$) higher fibre compared to the control sample. *Moringa* leaf enriched cookies had significantly higher carbohydrate than the control cookie sample (62.32%). Sensory scores showed highest acceptability with the control cookie samples (8.30). Drying techniques significantly decreased the general acceptability of the *Moringa* enriched cookies compared to sample E (fresh *Moringa* leaves) with score of 7.10. Oven dried cookie sample (6.05) scored significantly lower ($p<0.05$) acceptability compared to all other samples. The general acceptability score of 6.05 to 7.10 on a 9 point hedonic scale showed that *Moringa* enriched cookies was also accepted by the panelists.

Keywords: drying techniques, quality characteristics, enriched cookies, *Moringa oleifera* leaves

1. Introduction
Cookies are a kind of confectionary product dried to low moisture content (Okaka, 2009) [31]. Cookies tend to be larger with softer chewable texture compared to biscuits (IFIS, 2005). They are consumed all over the world as snack food on a large scale in developing countries where protein energy-malnutrition is prevalent (Chinma and Gernah, 2007) [6]. Malnutrition is the insufficient, excessive or imbalanced consumption of nutrients (O'Sullivan and Sheffrin, 2003) [34]. The World Health Organisation cites malnutrition as the gravest single threat to the world's public health. A number of different nutritional disorders such as celiac disease, diabetes and coronary heart diseases may arise, depending on which nutrients are under or over abundant (Jade *et al.*, 2013) [19] as a result of increase in consumption of these confectionary products. This led to the current trend in nutrition which is the consumption of functional foods advocated by World Nutrition Bodies due to these health related problems with wheat flour consumption (WHO/FAO, 2003) [43]. This situation has created the need for the consumption of low-carbohydrate diets, slowly digested starchy foods as well as an increased intake of functional foods (Hurs and Martin, 2005) [16]. Based on this, snack products with functional ingredients have been reported by different scientist from the blends of wheat/cowpea flours (Okaka and Isieh, 1990) [30], wheat/soybean (McWatters *et al.*, 2003) [25], wheat/full fat soya (Ndife *et al.*, 2014) [27]; wheat/cashew-apple residue (Ebere *et al.*, 2015) [8, 9], plantain/Bambara groundnut protein concentrate (Kiin-Kabari and Giami, 2015) [8, 9, 21] and blend of *Moringa* leaf powder/wheat flour (Gashaw *et al.*, 2015) [14].

Moringa leaves can be consumed either in raw, cooked or dried over a screen for several days and ground into a fine powder that can be added to almost any food as a nutrient enrichment (Makker and Becker, 1996) [23] and as a functional ingredient. Addition of dried *Moringa* leaf powder to any dish and its consumption has the potential to prevent problems of malnutrition in the populace (Yisehak *et al.*, 2011; USAID, 2012) [44, 40]. The dried *Moringa* like most vegetables are normal phenomenon in open markets found in most West African countries where they are sold (Mensah *et al.*, 2012) [26]. Scientists have used dried *Moringa* for the extraction of biological active compounds. Effect of drying techniques on the proximate and other nutrient composition on *Moringa* leaves have been studied by Mbah *et al.*, (2012) [24]. Adeyemi *et al.*, (2014) [1] carried out a research on the influence of drying methods on the proximate and phytochemical composition of *Moringa* leaves. Effect of drying methods on the physico-chemical and sensory properties of cookies fortified with *Moringa* leaves were reported by Emelike *et al.*, (2015) [8, 9]. *Moringa oleifera* is one of the lesser known vegetables found in Nigerian ecosystem with highly nutritious leaves, significant source of ß-carotene, vitamin C, iron, potassium and protein. Its protein quality compares very well with that of milk and egg (Gardener and Ellen, 2002; Emelike *et al.*, 2015) [13, 8, 9]. To alleviate the problems of malnutrition as a result of inadequate diet in developing countries, there is need for a cheap and available source of protein like *Moringa* leaves as food enricher since animal protein is very expensive and beyond the reach of the common man. Suchada *et al.*, (2010) [38] carried out a research on eleven different samples of *Moringa oleifera*

cultivated in Thailand and reported that these leaves were found to contain protein that ranges from 19.15 – 28.80%. Enrichment of cookies with this *Moringa* leaves may then be exploited to increase its macro- and micro-nutrients as a means of boosting nutrition in Africa, Asia and Nigeria where malnutrition is prevalent (Ogunsina and Radha, 2011) [29]. For health conscious individuals, *Moringa* leaf powder can be added to any meal to make it more nutritious. Therefore, the purpose of this study is to prepare cookies devoid of egg and milk enriched with *Moringa* leaf powder and to analyse the influence of drying techniques on the moisture content of the dried leaves and the quality characteristics of the resultant cookies which included the physical, chemical and sensory properties of the product.

2. Materials and Methods

2.1. Materials

Moringa (*Moringa oleifera*) leaves were harvested from the Diplomat Farms and Services Limited (*Moringa* and Mushroom farm), a research centre in the Rivers State University of Science and Technology. Baking items as flour (Dangote), margarine (Simas), sugar (Double crown), baking powder (Double crown), vanilla essence (Foster Clark's), salt (Anapuna) and nutmeg (Goodluck Super Quality) were all purchased from a bakery shop in Mile 3 Market at Port Harcourt, Rivers State, Nigeria.

2.2 Preparation of *Moringa* Leaf Powder

Moringa leaf powder was prepared according to the method reported by Emelike *et al.,* (2015) [8, 9]. *Moringa oleifera* leaves were harvested from stem by hand, sorted and weighed with total weight of 1.5kg. This was further divided into three parts of 500g, each for the three methods of drying (shade drying, sun drying and oven drying). Each part was washed under a running tap and damped with a clean cloth to remove excess water. The sample for shade drying were spread in two trays and placed on a high plane in the shade while the sample for sun drying were also spread in two trays on a table under the sun. The last part was spread in two foiled trays in air circulating oven (Gallemtanp S/No 90/20/190, UK) at 50^{o}C for 12h to achieve the oven dried sample. Fresh *Moringa* leaves were harvested on the day of incorporation, sorted, weighed, washed and milled. All samples (fresh and dried) were milled (Foss, Cyclotec 1093, Sweden). Fresh sample formed a paste after milling while dried samples were sieved into powder to pass 250 micron particle size sieve.

2.3 Preparation of Cookies

Wheat flour was sieved using 250 micron particle size sieve and mixed with other ingredients (baking powder, salt, sugar, nutmeg and *Moringa* powder) to ensure uniform incorporation. Margarine was rubbed in until a texture in a form of bread crumbs was formed. Water, flavour and vanilla essence was added to produce dough. Rolled out in a clean flour-dusted surface and cut into small circular sizes of about 3cm in diameter and 0.5 cm in height. An average of 70 cookies were cut from each sample and lined in a greased baking pan and baked at 160^{o}C in the oven (Omega Dako, Model-Ms 209) for 20 min. The cookies were allowed to cool at a room temperature (30±2^{o}C) and used for analyses.

Table 1: Formulation of *Moringa* Cookie Recipe

Samples	Flour (g)	Margarine (g)	Sugar (g)	Baking Powder(g)	Salt (g)	Vanilla Essence(mg)	Nutmeg (g)	Water (ml)	*Moringa* (g)	Milk (g)	Egg
WF	200	100	60	5	2.5	5	2.5	50	0	5	1
FL	200	100	60	5	2.5	5	2.5	50	10	0	0
SHD	200	100	60	5	2.5	5	2.5	50	10	0	0
SD	200	100	60	5	2.5	5	2.5	50	10	0	0
OD	200	100	60	5	2.5	5	2.5	50	10	0	0

Source: Emelike *et al.,* (2015) [8, 9]

Key: Wheat flour (WF), fresh *Moringa* leaves (FL), Shade dried M*oringa* leaves (SHD), Sun dried *Moringa* leaves (SD), Oven dried *Moringa* leaves (OD).

2.4. Physical Properties

The cookie weight, diameter, height and spread ratio were measured using five randomly selected cookies from each sample as described by Oyewole *et al*., (1996) [35] and modified by Emelike *et al.,* (2015) [8, 9] for *Moringa* fortified cookies. Cookies' weight was taken by scaling five cookies from each sample and the average noted. The diameter (D) was measured by taking two measurements from one cookie in 90^{o} rotations. A total of five cookies were measured from each sample and the mean noted. The height (thickness) of five cookies was measured by taking three measurements from one cookie and the mean value of the total five was noted.

2.5. Chemical Analysis

The recommended methods of Association of Official Analytical Chemist (AOAC, 2012) [4] were used to determine the influence of drying techniques on the moisture content of the dried *Moringa* leaves and the chemical properties of the cookies for moisture, crude protein, crude fibre, fat and ash. Total carbohydrate was determined using the Clegg Anthrone reagent method as described by Osborne and Voogt (1978) [33].

2.6. Sensory Analysis

Sensory analysis of the cookies was carried out after baking using the method described by Giami and Barber (2004) [15] for fluted pumpkin cookies. A panel of twenty (20) consumers comprising staff and student from Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria was used. Criteria for selection were that panellist were 16 years of age, regular consumers of the cookies and were neither sick nor allergic to any food. Panellists were trained in the use of sensory analysis procedures. At each session, five coded cookie samples were served on white disposable saucers, properly coded with 5-digit random numbers to prevent bias. The sensory attributes of the cookies including appearance, taste, aroma, texture, crispness and general acceptability was evaluated using a 9 – point hedonic scale with 1 representing the least score and 9 the highest score (dislike and like extremely, respectively), multiple comparison that was used to evaluate the differences

between samples as described by Iwe (2002) [18]. Necessary precautions were taken to prevent carryover flavour during the tasting by ensuring that panelists rinse their mouth with water after each evaluation.

2.7 Statistical Analysis

Results were expressed as mean values and standard deviation of five determinations. Data were analysed using a one-way analyses of variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0 software 2011 to test the level of significance ($p<0.05$). Duncan New Multiple Range Test was used to separate the means where significant differences existed as described by Wahua (1999) [41].

3. Results and Discussion

3.1. Physical Properties

Physical properties of cookies enriched with fresh and dried *Moringa* leaf samples including the control sample (100% wheat flour cookies) is presented in Table 2. This was done to utilize cheap and available plant vegetable protein source to replace the expensive animal protein (milk and egg) in cookies production and to produce cookies that vegetarians can benefit from. Ten percent (10%) enrichment of *Moringa* leaf samples significantly lowered ($p<0.05$) the weight of the cookies compared to the control cookie samples with the weight of 6.70g. This is similar with the report of Emelike *et al.,* (2015) [8, 9] who observed a significant reduction in cookie weight fortified with 5% *Moringa* leaf samples. Sun and shade drying techniques rendered no significant effect in the cookie weight compared to cookies enriched with fresh *Moringa* leaves. Cookies enriched with oven dried *Moringa* leaves had significantly higher weight than other *Moringa* enriched cookies. This is in agreement with the result of Ebere *et al.,* (2015) [8, 9] who observed a significantly higher weight in cookies substituted with 10% oven dried cashew apple fibre. Chinma *et al.,* (2012) [7] reported an increase in weight of weight of cookies at increasing substitution levels of wheat flour with sesame flour blends. The height of the cookies ranged between 0.65 – 0.96cm for samples B and A, respectively. This result showed that 10% *Moringa* leaf enrichment and drying techniques studied significantly did not affect the height of the produced cookies except sample B (oven dried sample) with slightly lower height. This did not agree with the report of Kiin-Kabari and Giami (2015) [8, 9, 21] who observed significant increase and decrease in the cookie height substituted with Bambara groundnut protein concentrate. This could be associated with different levels of Bambara groundnut protein concentrate utilized by these researchers, as a constant 10% *Moringa* leaf samples was used in this research. It could also be the utilization of different protein sources. The value for diameter ranged from 3.29cm to 4.01cm for samples D and B (shade and oven dried) samples, respectively. There was no significant difference in the cookies' diameter produced with oven and sun (sample B and C) dried *Moringa* leaf powder with the values of 4.01cm and 3.84cm, respectively. These two samples were found to have significantly higher diameter compared to shade dried cookie samples (sample D) with 3.29cm of diameter. There was no significant difference in the diameter of cookies enriched with 10% fresh *Moringa* leaf (3.67cm) and those produced with 100% wheat flour (3.47cm). This is similar with the report of Kiin-Kabari and Giami (2015) [8, 9, 21] for the diameter of cookies substituted with Bambara groundnut protein concentrate. The highest spread ratio (6.33) was observed in cookies enriched with oven dried *Moringa* leaf sample. There was no significant difference in the spread ratio of cookies enriched with fresh (4.52) and shade (4.26) dried *Moringa* leaf samples. Sample A (100% wheat flour) had significantly lower spread ratio (3.71) compared to other samples. A significantly lower spread ratio was equally reported by Emelike *et al.,* (2015) [8, 9] for cookies produced with 100% wheat flour compared to those fortified with dried *Moringa* leaf samples. Emelike *et al.,* (2015) [8, 9] stated that *Moringa* contains a salient source of fibre that is absent in wheat flour which could have increased the swelling capacity of *Moringa* enriched cookies. Oyewole *et al.,* (1996) [35]; Ogunjobi and Ogunwolu (2010) reported that fibre has the ability to absorb more water up to 15 times and swelling up in size. A reverse case was observed by Ebere *et al.,* (2015) [8, 9] who reported a significantly higher spread ratio in cookies produced with 100% wheat flour compared to those substituted with cashew apple residue. They further stated that this could be associated with the gluten content in 100% wheat flour devoid in cashew apple residue that is responsible in the spreading characteristics of dough. This is to say that dried *Moringa* leaves might contain good amount of this gluten leading to the higher spread ratio of the produced cookies. Generally, cookies produced with 100% wheat flour (sample A) had significantly higher weight (6.70g) and height 0.96cm, lower diameter (3.47cm) and spread ratio 3.71. Oluwamukom *et al.,* (2010) [32] stated that the enrichment of biscuit with soy flour at substitution level above 40% resulted in increase in diameter and spread ratio with an initial decrease in weight.

Table 2: Physical Properties of *Moringa* Enriched Cookie Samples

Sample	Weight (g)	Height (cm)	Diameter (cm)	Spread ratio
A	6.70^{a}	0.96^{a}	3.47^{b}	3.71^{d}
B	6.37^{b}	0.65^{ab}	4.01^{a}	6.33^{a}
C	6.21^{c}	0.75^{a}	3.84^{a}	5.20^{b}
D	6.23^{c}	0.78^{a}	3.29^{bc}	4.26^{c}
E	6.18^{c}	0.83^{a}	3.67^{b}	4.52^{c}

^{a,b,c,d} Means with similar superscripts in the same column are not significantly different at 5% levels of probability ± standard deviation of three determinations.

Key: Sample A (100% wheat flour), B (10% oven dried *Moringa* leaves), C (10% sun dried *Moringa* leaves), D (10% shade dried M*oringa* leaves), E (10% Fresh *Moringa* leaves) enrichment.

3.2. Chemical Properties

Drying techniques significantly affected the moisture content of the *Moringa* enriched cookie samples as shown in Table 3. Cookies produced from fresh *Moringa* leaves (sample E) had significantly higher ($p<0.05$) moisture content of 6.86%. There was no significant difference in the cookies made from sun

(sample A) and shade (sample D) dried *Moringa* leaf powder with the values of 6.23% and 6.34%, respectively. Only the cookies produced from oven dried (sample B) *Moringa* leaf powder compared favourably with the control cookie samples (4.39 and 4.22%), respectively. These values are low compared to 10% recommended by FAO (2005) for dried vegetable products. Smith (1972) [36] established that moisture content of cookies should not exceed 14%. Okaka (2009) [31] equally reported low moisture content of cookies. However, they fall within the range of 5.2 – 6.9% and 4.19 – 5.88% reported by Ebere *et al.,* (2015) [8, 9]; Emelike *et al.,* (2015) [8, 9] for cookies produced with cashew apple residue and *Moringa* leaf powder, respectively. As well as a range of 5.4 – 6.8% for cookies enriched with Bambara groundnut protein concentrate reported by Kiin-Kabari and Giami (2015) [8, 9, 21]. High moisture content encourages microbial proliferation that leads to spoilage, as they have been associated with short shelf life of baked products (Ezeama, 2007; Akhtar *et al.,* 2008; Elleuch *et al.,* 2011) [11, 2]. Highest protein content of the produced cookies was observed in the samples B and C (oven and sun dried) 10.43 and 10.37%, respectively and showed no significant difference ($p<0.05$). Protein content of cookies produced from shade dried (9.92%) and fresh leaves (9.93%) compared with the control cookie sample 9.99%. Emelike *et al.,* (2015) [8, 9] reported protein content of cookies fortified with 5% *Moringa* leaves to compare favourably with the control cookie sample. This is an indication that 10% well dried *Moringa* leaves contains more protein value compared to the amount in milk and egg. The protein value of the produced cookies are high compared to 4.31% for blended plantain flour reported by Arisa *et al.,* (2013) [5], as well as 7.53% reported by Ndife *et al.,* (2014) [27] for 20% soy-flour substitution in cookie production. This is an evident that *Moringa* leaves can be oven or sun dried and used as a cheap source of protein to replace the use of milk and egg in baked products. The dried *Moringa* leaves can as well be used to produce cookies rich in plant protein for vegetarians' consumption and health conscious individuals. Mbah *et al.,* (2012) [24] reported sun and oven dried *Moringa* leaf powder with protein values of 24.43% and 25.13%, respectively. Adeyemi *et al.,* (2014) [1] equally reported oven, shade and sun dried *Moringa* leaves with protein contents of 15.837, 11.747 and 22.523mg/100g, respectively. According to Wardlaw (2004), protein is necessary for growth, building body blocks and for repair of damaged tissues. Significantly higher ($p<0.05$) fibre was observed in cookies produced from sun dried (2.44%) and fresh *Moringa* leaves (2.49%) with no significant difference in their values. This is followed by cookies made from oven and shade dried samples (1.65 and 1.53%), respectively. Cookies from 100% wheat flour had significantly lower fibre of 1.05%. This is an indication that *Moringa* leaves are good sources of fibre. Jadhas *et al.,* (2000) [20] stated that *Moringa* leaves are high in fibre. Increase in fibre aids digestion, thereby prevents constipation. Lisa (1997) [22] reported that fibre have the ability of cleansing digestive tract by removing potential carcinogens from the body and preventing the absorption of excessive cholesterol. Cookies produced from oven dried *Moringa* leaf powder (sample B) had significantly higher fat (19.06%) while the control sample had significantly higher (20.32%) compared to other samples. This trend was observed in the ash content of the cookie samples. The only difference is that a significant difference was not recorded in the ash content of all the *Moringa* enriched cookies. Emelike *et al.,* (2015) [8, 9] equally reported a decrease in fat and ash contents of cookies fortified with 5% *Moringa* leaf samples. A reverse case was reported by Aluko *et al.,* (2013) [3] of an increase in fat and ash values with incorporation of *Moringa* seed flours. This difference could be attributed to high oil content in *Moringa* seed flours. Subadra and Monica (1997) [37] reported that *Moringa* leaves contain low fat compared to *Moringa* seeds. Adeyemi *et al.,* (2014) [1] equally reported low fat contents of dried *Moringa* leaves.

Table 3: Chemical Properties of *Moringa* Enriched Cookie Samples

Sample	Moisture (%)	Crude Protein (%)	Crude Fibre (%)	Fat (%)	Ash (%)	Total Carbohydrate (%)
A	4.22^{c}	9.99^{b}	1.05^{c}	20.32^{a}	2.06^{a}	62.32^{b}
B	4.39^{c}	10.43^{a}	1.65^{b}	19.06^{c}	1.73^{b}	63.91^{a}
C	6.23^{b}	10.37^{a}	2.44^{a}	19.83^{b}	1.67^{b}	63.87^{a}
D	6.34^{b}	9.92^{b}	1.53^{b}	19.64^{b}	1.41^{bc}	63.86^{a}
E	6.86^{a}	9.93^{b}	2.49^{a}	19.70^{b}	1.71^{b}	70.01^{a}

^{a,b,c,} Means with similar superscripts in the same column are not significantly different ($p>0.05$) ± standard deviation of three determinations.

Key: Sample A (100% wheat flour), B (10% oven dried *Moringa* leaves), C (10% sun dried *Moringa* leaves), D (10% shade dried M*oringa* leaves), E (10% Fresh *Moringa* leaves) enrichment.

3.3. Sensory Properties

Sensory scores of *Moringa* leaf enriched cookies showed that the control (sample A) cookie was preferred in all the organoleptic attributes analysed except the crispness of cookies enriched with fresh *Moringa* leaves (samples E) which showed no significant difference compared to sample A with the scores of 7.45 and 7.50, respectively as presented in Table 4. Sample B with the least moisture content produced smoother powder after milling compared to other samples. However, cookies enriched with it were completely green in appearance and showed significantly lower acceptability scores in both appearance (5.40) and general acceptability (6.05). Teye *et al.,* (2012) [39] stated that when the colour of a new product differs significantly from the control products, consumers see it as a sign of spoilage and thereby reject them. This is supported with the report of Ogunsina and Radha (2011) [29] who in their study of replacing 30% debittered *Moringa* seed flour with wheat flour affected the cookies sensory characteristics. Cookies enriched with *Moringa* leaf samples had general acceptability score of 6.05, 6.70, 6.35 and 7.10 for samples B, C, D and E, respectively on a 9 point hedonic scale. This is an indication that *Moringa* leaf enriched cookie samples were also accepted by the panelists. This result is in agreement with the report of Emelike *et al.,* (2015) [8, 9] for 5% dried *Moringa* leaves' enriched cookies. It is necessary to carry out a research on how to reduce the natural greenish colour in *Moringa* leaves in increase its acceptability when used in baked products.

Table 4: Sensory Properties of *Moringa* Enriched Cookie Samples

Samples	appearance	Taste	Aroma	Texture	Crispness	General acceptability
A	8.30[a]	7.90[a]	7.55[a]	7.65[a]	7.50[a]	8.30[a]
B	5.40[d]	6.55[b]	6.00[c]	6.15[c]	5.65[c]	6.05[e]
C	5.95[c]	6.80[b]	6.65[b]	6.40[b]	5.95[b]	6.70[c]
D	5.85[c]	5.70[c]	5.80[c]	6.10[c]	5.50[c]	6.35[d]
E	7.25[b]	6.55[b]	6.75[b]	6.50[b]	7.45 [a]	7.10[b]

[a,b,c,d,e] Means with similar superscripts in the same column are not significantly different (P > 0.05).
Key: Sample A (100% wheat flour), B (10% oven dried *Moringa* leaves), C (10% sun dried *Moringa* leaves), D (10% shade dried M*oringa* leaves), E (10% Fresh *Moringa* leaves) enrichment.

4. Conclusion

Moringa leaf enriched cookies were produced from wheat flour to study the effect of drying techniques on the physicochemical and sensory properties of the resultant product. It was also a means of utilizing cheap and available plant protein source to replace milk and egg that is hardly within the reach of a common man in baked products. The result showed that *Moringa* enriched cookies thrived comparatively with the control products not distorting to a great extent the physical characteristics of the cookies. Enrichment of cookies with 10% oven and sun dried *Moringa* leaf powder had significantly higher protein values compare to the control sample. *Moringa* enriched cookies were also found to contain more fibre than the control cookies. Cookies produced from 100% wheat flour showed significantly higher sensory attributes more than cookies with *Moringa* enrichment. The fact that general acceptability of *Moringa* enriched cookies ranged between 6.05 (sample B) – 7.10 (sample E) on a 9 point hedonic scale equally showed their acceptability by the panelists. However, drying *Moringa* leaves and its utilization could help alleviate protein deficiency malnutrition and reduce the cost of cookies. Further studies are therefore on-going to ascertain the in-vitro protein digestibility of the produced cookies.

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