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Effect of addition of *moringa oleifera* leaf on the nutritional quality, microbial and sensory properties of spices

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Abstract

Spice was produced using blends of Moringa oleifera *leaf, ginger and garlic. The sensory, chemical and microbial assessment of Moringa based spice was evaluated. The formulation was grouped into nine blends in ratio 25:75:0, 20:80:0, 15:85:0, 25:0:75, 20:0:80, 15:0:85, 25:37.5:37.5, 20:40:40, 15:42.5:42.5 for Moringa-ginger-garlic respectively. Sensory evaluation revealed that blends with 20% moringa were more preferred in terms of aroma, taste, flavour, appearance, texture and overall acceptability. The most preferred blends were further subjected to proximate and microbial analysis. The proximate composition of the preferred blends were similar with moisture, protein, fat, ash and carbohydrate contents ranging between 8.1-9.2, 23.8-25.5, 2.7-3.0, 54.0-55.4% respectively. Microbial load of all the blends decreased during storage period. However, moringa-ginger blend showed significantly low microbial count compared to other blends. This study suggests that moringa based spice products with 20% inclusion of moringa are acceptable and can be use as spice in different household consumable product.*

Keywords: *Moringa leaf, garlic, ginger, spice, proximate, sensory and microbial*

Introduction

Spices are used all over the world for culinary purposes. They are farm products used in various forms such as fresh, ripe, dried, broken, and powdered to contribute to taste, aroma, flavour, colour and pungency of food (Parveen et al., 2014). Beside the culinary uses, spices have also been recognised to possess several medicinal properties (Srinivasan, 2005). They are complex mixtures of natural antioxidants, phytochemical, vitamins and minerals (Dwyer, 2014). Spices can be made from bark, buds, flower, fruits, leaves, rhizomes, roots, seeds, stigmas and sometimes the entire plant may be used as spice (Takeda et al., 2008). Ginger, garlic, cinnamon, pepper, turmeric among others are plants that are used in form of spices (Jung et al., 2014)**.** Garlic (*Allium sativum*), ginger (*Zingiber officinale*) and pepper (*Capiscum nigrum*) are common spices used in most cuisines all over the world and have been reported to have anti-dyspeptic, anti-flatulent, anti-bacterial, anti-fungal, anti-diabetic effects as well as ability to mitigate the effect of alcohol (Srinivasan, 2005)**.**

Specifically, consumption of garlic has been reported in having potential to reduce arterial plaque and possess antioxidant properties on skin cancer (Koscienly et al., 1999). In addition, the consumption of ginger has also been reported in leading to reduction in blood cholesterol and also served as a potential anti-inflammatory and antithrombotic agent (Thomson et al., 2002).

The use of *Moringa oleifera* leaf powder as a spice has not been reported, but many authors have stated the immense benefit of this wonder plant. Studies have shown that the leaves are rich sources of minerals, vitamins and amino acids (Anjorin et al., 2010, Wakil and Kazeem, 2012). Recent studies have demonstrated the potential bioactive properties of *Moringa oleifera* leaves and also showed the enrichment of carotenoids, tocopherols along iron bioavailability in animal models (Saini et al., 2014). Therefore, the use of this wonder leaf powder in daily cuisine spices will be an indirect way of getting the numerous benefit of the leaf. This study is aimed at investigating effect of *Moringa oleifera* leaves on the sensory properties, nutritional quality and microbiological assessment of spice formulated from ginger and garlic.

Materials and methods

Sample collection

Ginger (*Zingiber officinale*) and garlic (*Allium sativum*) were purchased at Oja Oba in Ilorin, Nigeria. *Moringa oleifera* leaves were obtained from University of Ilorin moringa plantation, Ilorin, Kwara State, Nigeria. They were harvested in the early hours at about 8 a.m. and transported to the laboratory which is about 2 km from the plantation in cleaned polyethylene bags for further processing.

Processing of Ginger, garlic and moringa leaf

The ginger roots were washed, sorted, peeled, diced and dried using a microwave oven at high temperature for 30 min. The dried samples were ground into fine powder using an electric blender. The garlic was removed from the cloves, sliced and dried in the microwave oven at medium temperature for 20 min after which the peels were removed and the samples were grounded into fine powder using an electric blender. Moringa leaves were dried using cabinet tray dryer. The dehydrated leaves were grounded into fine powder, kept in Ziploc and refrigerated at 4 °C until further use.

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Formulation of the Spice

Spices were formulated into nine blends using different ratio using Moringa, ginger and garlic (Table 1) as described by Wakil and Kazeem (2012).

Table 1. *Composition of the various blends*

Blends	Moringa (%)	Ginger (%)	Garlic (%)
Blend 1	25	75	0
Blend 2	20	80	0
Blend 3	15	85	0
Blend 4	25	0	75
Blend 5	20	0	80
Blend 6	15	0	85
Blend 7	25	37.5	37.5
Blend 8	20	40	40
Blend 9	15	42.5	42.5

Spice production

The spice powders were mixed in various ratios: Moringa-ginger, Moringa-garlic and Moringa-ginger-garlic. The ratios were properly mixed using electric blender for homogeneity.

Sensory evaluation of spiced beef

Formulated spices were used to cook diced beef samples. The spices (500 mg), salt (50 mg) and water (100 ml) were cooked with beef for 15 minutes. Cooked beef were presented in the sensory room to fifty trained panellists of female lecturers (Age 30-45) from University of Ilorin, Ilorin, Kwara State, Nigeria. White bulbs were fitted in the sensory room to detect the genuine colour of the sample. The samples were assessed for aroma, taste, colour, texture and overall acceptability. The panellists were instructed to sip water before and after assessing each product. The panellists were in good health and are familiar with the taste, flavour and other attributes of spices. The evaluation started around 1 p.m. The samples were assessed using 9 point hedonic scale ranging between 9 (likely extremely) to 1 (dislike extremely). Like extremely 9; like very much 8; like moderately 7; like slightly 6; neither like nor dislike 5; dislike slightly 4; dislike moderately 3; dislike very much 2; dislike extremely 1.

Proximate analysis

The most acceptable samples were investigated for proximate analysis. Moisture, Ash, fat and crude fibre were determined using AOAC methods (**AOAC,** 2000). The protein content was determined by kjeldahl method (Nx6.25). Total carbohydrate was calculated by difference as expressed below.

Carbohydrate = 100 – (Moisture + Ash + Fat + Protein)

Microbial analysis

The most acceptable spices were further subjected to microbial analysis. Total viable count was carried out using the methodology described in Fawole and Oso (2004) , with some modifications. 1 g of representative sample was put into a sterile test tube containing 9 ml of ringer's solution; the sample was mixed thoroughly by shaking to 10 serial dilutions. 1 ml of each dilution was aseptically transferred into duplicate sets of disposable sterile petri-dishes and small amount of nutrient agar broth was poured on each of them. The petri-dishes were swirled gently and allowed to solidify. The samples were incubated at 37°C for 24 h after which the colonies were counted using a colony counter.

Statistical analysis

All experiment were conducted in triplicates and subjected to analysis of variance using statistical package for social science (SPSS).

Results and Discussion

Sensory analysis of the cooked beef indicates a significant difference ($P \leq 0.05$) in terms of aroma, taste, colour, texture and overall acceptability. The result shows that blend 2 (20% moringa + 80% ginger), blend 5 (20% moringa + 80% garlic) and blend 8 (20% moringa + 40% ginger + 40% garlic) had higher ratings for aroma, colour, texture and overall acceptability among the fortified samples (Table 2). Blends 2, 5 and 8 had similar ratings for overall acceptability. This result is in agreement with the findings of Arise et al. (2014), who reported that 20% inclusion of moringa flower incorporated into gruel were the most acceptable out of seven blends of different ratios of 5,10,15.20 and 25%.

There was no significant difference in the colour of blends 2, 5 and 8. The three blends are the most accepted for colour. Blends 4 and 7 with 25% inclusion of moringa leaf were least accepted for colour. This may be due to the sharp green colour of the moringa leaf masking the colour of ginger and garlic at higher percentage therefore affecting the colour of the cooked beef.

The ratings for taste and aroma were presented in Table 2. Blend 3 (15% moringa with 85% ginger) had the lowest rating (4.5). This could be ascribed to higher percentage of ginger present in the blend. Ginger has been described as having warm spicy taste, sometimes termed as peppery (Huang et al., 2012). Blend 8 (moringa-ginger-garlic; 20:40:40) had the highest ra-

Table 2: *Sensory attributes of the blends*

Parameter	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Blend 6	Blend 7
General acceptability	$5.10^a \pm 0.05$	$5.17^a \pm 0.04$	$5.33^b \pm 0.10$	$6.67^d \pm 0.02$	$6.67^d \pm 0.01$	$7.67^e \pm 0.03$	$6.33^c \pm 0.03$
Colour	$6.50^d \pm 0.04$	$5.17^a \pm 0.02$	$6.17^b \pm 0.01$	$6.33^c \pm 0.02$	$6.60^{de} \pm 0.10$	$7.33^f \pm 0.01$	$6.67^e \pm 0.03$
Taste	$7.00^e \pm 0.10$	$6.33^c \pm 0.03$	$5.50^a \pm 0.10$	$6.67^d \pm 0.02$	$6.90^{de} \pm 0.05$	$7.83^f \pm 0.01$	$6.00^b \pm 0.10$
Aroma	$7.50^e \pm 0.03$	$5.83^b \pm 0.04$	$5.50^a \pm 0.02$	$6.33^c \pm 0.01$	$6.50^d \pm 0.03$	$8.33^g \pm 0.02$	$7.90^f \pm 0.04$
Texture	$6.67^d \pm 0.03$	$6.67^d \pm 0.04$	$4.83^c \pm 0.03$	$4.83^c \pm 0.01$	$4.50^b \pm 0.04$	$4.30^a \pm 0.02$	$4.20^a \pm 0.05$

Mean ± SD. Means values followed by different superscripts in each column is significantly different at $P \leq 0.05$.

Table 3. *Proximate composition of the three blends (%)*

Blends	Moisture	Protein	Fat	Ash	^{x}Carbohydrate
Blend 2	$9.15^{c} \pm 0.07$	$23.76^{a} \pm 0.04$	$5.97^{c} \pm 0.25$	$7.08^{a} \pm 0.08$	$54.04^{a} \pm 0.01$
Blend 5	$8.15^{b} \pm 0.03$	$25.45^{c} \pm 0.05$	$2.94^{a} \pm 0.55$	$7.95^{b} \pm 0.05$	$55.14^{b} \pm 0.18$
Blend 8	$8.1^{a} \pm 0.01$	$24.45^{b} \pm 0.05$	$4.02^{b} \pm 0.25$	$8.05^{b} \pm 0.07$	$55.38^{b} \pm 0.04$

Mean ± SD. Means values followed by different superscripts in each column is significantly different at $P \leq 0.05$. ^{x}Carbohydrates is calculated by difference. Blend 2 Moringa-ginger, Blend 5 Moringa-garlic and Blend 8 Moringa-ginger-garlic.

ting in term of taste and aroma. This may be attributed to the fact that blend 8 is made up of equal amount of garlic and ginger which could have impacted the aroma. Previous studies indicated that the volatile compounds of ginger and garlic plays a role in impacting flavour (Huang et al., 2012) .

Ratings for texture of beef cooked with the blend shows that blends 2, 5 and 8 had higher rating compared to other blends. The inclusion of 20% moringa into the spice blends has shown a great improvement on the sensory quality of the blend. Interestingly, the inclusion of moringa leaf is accepted by the panellist as safe as none of the panellists developed any side effects such as diarrhoea and emesis after consuming the blends.

Proximate analysis

The proximate composition of blends 2, 5 and 8 which were the most preferred in terms of sensory properties are shown in Table 3. Protein content (23.76 to 25.45%) and carbohydrate (54.04 – 55.38%) are the major nutrient in the three spice blend. In general, the protein contents of the blends are higher than values reported garlic (15.33%) and ginger (8.58%) respectively (Otunola et al., 2010, Nwinuka et al., 2005). Moringa leaves are rich in protein (Oduro et al., 2008, Jongrungruangchok et al., 2010, Omotesho et al., 2013) and this may explain the high protein content of the formulated spices. Among the three blends, blend 5 (moringa- garlic) had the highest protein content of 25.45%. Garlic inclusion to blend 5 may have contributed to its higher protein content compared to other blends. Previous studies reported that garlic are also sources of protein (Otunola et al., 2010, Nwinuka et al., 2005).

Moisture (8.1 - 9.15%), ash (7.08 - 8.05%) and fat (2.94-5.97%) contents were generally low. Moisture content reported for garlic and ginger separately were lower than the ones obtained for the blends (Otunola et al., 2010, Nwinuka et al., 2005). Blend 8 (moringa-ginger-garlic) had the lowest moisture content. This indicates that blend 8 may have a better shelf life compared to blend 2 and 5 as spoilage microbes thrive better in the presence of adequate moisture.

Low fat content of food is indicative of high keeping quality. This is remarkable as it enhances its keeping quality. Fat can undergo oxidative deterioration which leads to rancidity, thereby reducing the shelf life of the food sample. Hence, a food with high fat content is prone to spoilage than one with low fat content. However, blend 2 had the lowest fat content (2.94%) in comparison to other blends. The lowest fat content observed in this blend may be as a result of low fat content reported for garlic and moringa respectively (Omotesho et al., 2013, Oduro et al., 2008, Nwinuka et al., 2005, Otunola et al., 2010) .

The ash content of the blends increases with inclusion of moringa leaf. This indicates that moringa leaf could be a good source of mineral (Moyo et al., 2013) **.** The highest ash content was obtained for blend 8. This may be attributed to the presence of the moringa, ginger and garlic.

The three blends contained appreciable amount of carbohydrate (54.04-55.38%), suggesting that they can be ranked as carbohydrate rich spices. One of the characteristic of spice is its high carbohydrate content (Otunola et al., 2010, Nwinuka et al., 2005)**.**

Microbial analysis

Total bacteria count was performed on the blends stored over a period of six weeks (Table 4). The bacteria load decreased slightly throughout the storage period, possibly due to the dry nature of the spices and their inherent anti-microbial properties. Among the spices blend 2 (Moringa-ginger) showed the lowest level of bacterial load. This may be attributed to zingerone present in ginger which makes re-absorption of moisture extremely difficult and defends the inner part of it against microbial invasion (Johji et al., 1985, Surh et al., 1998). The total bacterial count obtained for all the blends is in agreement with the findings of Parveen et al. (2014). The author reported total count of 3.00-8.53 x 10^{4} cfu/g for turmeric, red pepper and coriander. The result obtained in this research shows that inclusion of moringa leaf does not increase the total microbial load of the spice.

Conclusion

The study showed that the proximate composition, microbial and organoleptic properties of spices could be enhanced through the addition of moringa oleifera leaf. The protein content of the three blends that were subjected to proximate

Table 4. *Total plate count of the blends (10^{4} cfu/g)*

Samples	Week 0	Week 2	Week 4	Week 6
Blend 2	3.60a ± 0.02	3.50a ± 0.02	2.90a ± 0.10	2.80a ± 0.10
Blend 5	3.75b ± 0.02	3.70a ± 0.05	3.55b ± 0.07	3.50b ± 0.10
Blend 8	5.25c ± 0.05	5.10b ± 0.1	5.0 °C ± 0.10	4.8 °C ± 0.10

Mean ± SD. Means values followed by different superscripts in each column is significantly different at $P \leq 0.05$. Blend 2 Moringa-ginger, Blend 5 Moringa-garlic and Blend 8 Moringa-ginger-garlic.

analysis increased significantly by 80%. Based on sensory evaluation conducted, blends with 20% moringa were found to be the most generally acceptable with low microbial load. Therefore, preparation of moringa based spice with 20% inclusion of moringa leaf could be recommended for use as spice for cuisines. This will promote the production of moringa as well as consumption of moringa especially by those averse to raw consumption of this ethno medicinal plant.

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