DESCRIPTIVE PROFILING ON SENSORY QUALITY ATTRIBUTES OF GLUTEN-FREE NOODLES PRODUCED FROM UNRIPE ORGANIC PLANTAIN FLOUR

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Abstract
This study was carried out to describe the sensory quality attributes of gluten-free noodles produced from unripe organic plantain (Musa paradisica L.) flour and to compare their acceptability to two branded commercial wheat flour noodles. The cultivar of matured full green plantain fruits used for this study named "agbagba" was obtained from Federal University of Agriculture, Abeokuta organic plantain demonstration conversion plot. Fruits were peeled and sliced into 3-4 mm thickness and dried in a cabinet drier at 60 °C for 24 h. Dried slices were milled into flour (600 µm size) and used to prepare six research noodle samples out of which only two were acceptable Org2 and Org3(noodles with 2.5 % and 3.5 % xanthan gum) respectively. These were packaged in high density polyethylene for further analyses. Descriptive sensory profile on the quality of dry and cooked noodles was carried out by 10 trained panelists and these qualities were compared to two commercial wheat flour noodles based on their colour, taste, texture, degree of shininess, firmness and overall acceptability. Results showed that the dry commercial noodles were more acceptable based on all the described attributes except texture where dry Org3 was more acceptable. All the cooked noodles were described to be mildly sticky with starchy mouth feeling. Commercial noodles were more acceptable based on colour (slightly yellow) with bland taste. Based on all the described sensory qualities, the commercial wheat flour noodles were more acceptable closely followed by Org3. Based on this study, it is recommended that gluten-free noodles produced from organic unripe plantain flour with 3.5 % xanthan gum which compared favourably with the branded commercial wheat flour noodles can be formulated with an improvement on its taste, colour and storage stability.

INTRODUCTION

Plantain (*Musa paradisca* L) is widely cultivated in Nigeria as one of the most important staple foods especially in the traditional humid rainforest production zone and also south eastern Nigeria (Baiyeri and Ajayi, 2000). Plantain fruits are also among the green vegetables with the richest iron and other nutrient contents but it is not well utilized (Aremu and Udoessien, 1990). Also, unripe plantain diet has been helpful in dietary management of type 2 diabetes and others include: "acha", beans, breadfruit in Nigeria (Eleazu and Okafor, 2012).

Noodles are made mainly from wheat and this major raw material for making noodles contains gluten protein (Osagie and Eka, 1998). It is equally important to note that presently, celiac disease (a disease of the digestive system that damages the small intestine and interferes with the absorption of nutrients from food) and cereal allergy (including wheat allergy) are great problems. As such, emphasis is now being placed on gluten/gliadin-free basic foods (Rasmay *et al*., 2000), since gluten-free diet is the only efficient treatment for celiac disease (Emire and Tiruneh, 2012).
One of the effects of the above is an increase in demand for gluten-free products such as pasta

therefore inspiring extensive gluten-free food product research and development (Schoenlechner *et al*., 2010).Osorio-Díaz *et al.*(2008) evaluated proximate compositions of noodles prepared from various mixtures of durum wheat flour and isolated plantain starch and Vijayakumar and Boopathy (2014) carried out optimization of ingredients for noodle preparation using response surface methodology. Furthermore, Flores-Silva *et al.* (2015) determined the physicochemical, textural and sensorial characteristics of gluten-free spaghetti elaborated with unripe plantain, chickpea and maize flours. Mastromatteo *et al*. (2011) evaluated the use of different nonconventional flours in the development of gluten-free pasta. However, more research is needed since nonconventional flours often do not have similar quality as that of durum wheat semolina.

Consumers are not willing to compromise when it comes to texture, taste, and flavor which poses a challenge for the food industry in terms of developing new healthy food products, as consumers will only repurchase a product that tastes good (Drewnowski, 1998). Therefore, more research is needed in describing the quality attributes of plantain-flour based gluten-free noodles to check if it possesses sensory properties that can compare favourably with the commercial wheat flour-based noodles. It is absolutely necessary that the consumers like the healthy alternative products.

Therefore, the aim of this study was to describe the quality attributes of gluten-free noodles produced from unripe organic plantain flour and compare same to the quality attributes of two branded commercial noodles made from wheat flour.

MATERIALS AND METHODS
Materials
Organic plantain cultivar "agbagba" was obtained from Federal University of Agriculture Abeokuta, (FUNAAB) organic plantain demonstration plot in Abeokuta, Ogun State, Nigeria.

Xanthan gum, iodized salt and olive oil were purchased from Chemicals' market, Lagos State, Nigeria while and two branded commercial noodles (BN1 and BN2) were purchased from Kuto Market, Abeokuta, Ogun state, Nigeria

Preparation of Noodles
The Organic plantain fruits were harvested at grade 1 maturity stage, weighed, the fingers were removed from the bunches, washed, hand peeled and sliced into about 3-4mm thickness under water using a slicer (Art no. H0ZG2-1, USA). The slices were dried in a cabinet dryer (Genlab DC1000, USA) at 60°C for 24h, milled into flour using attrition mill (SK-30-SS), sieved with a sieve of 600μm aperture size and packed in high density polyethylene film and sealed (Kure *et al.,* 1998). About 200g of flour was mixed with 130 ml distilled water, 0.3 % NaCl, 5 ml cold pressed olive oil and 0%, 0.5%, 1.5%, 2.5%, 3.5% and4.5% xanthan gum (to produce 6 research samples). The resultant dough was kneaded with hand for 5min, allowed to rest for 20min, then folded and sheeted through a pasta machine (VillaWare classic Italian Kichenware, Cleveland, OH) with the gap set at 4. The sheet was cut into strips of diameter 0.8mm and dried in the cabinet dryer at 60°C for 12h, packed and sealed in high density polyethylene film and kept for further analyses (Nagao *et al.,* 1996). A preliminary research study on the overall acceptability of the 6 research samples produced 2 acceptable samples. The two samples of plantain noodles (Org3: unripe organic plantain noodles with 3.5 % xanthan gum and Org2: unripe organic plantain noodles with 2.5 % xanthan gum) were more acceptable. These qualities of these research samples were described by 10 trained panellists and the qualities compared to 2 branded commercial samples of noodles (BN1 and BN2).

SAMPLES
Descriptive profiling of the noodle samples was carried out by 10 trained judges using a 5-point attribute scale formulated by them.
Organoleptic characteristics of the dried noodles were assessed by descriptive sensory profile on colour, appearance, surface smoothness and hardness. Acceptability based

on these characteristics was also determined. Descriptive profile of the cooked noodles was based on the sensory characteristics of colour, smoothness, firmness, stickiness and starchy mouth coating. The acceptability of the cooked noodles was carried out based on the colour, taste, flavor/aroma and texture (Bhat and Sharma,1989)

Statistical Analysis

All analysis was done in triplicate. Data obtained were subjected to Analysis of Variance (ANOVA) using SPSS version 19.0. Duncan Multiple Range Test was used to determine significant differences among treatment means.

RESULTS AND DISCUSSION

Paulus and Reisch (1980) defined sensory evaluation as the individual likeness and dislikes of a product as a result of biological variation in man and what people perceived as appropriate sensory properties. Also, brightness is a required colour for all noodles and creamy white colour is the best noodle colour and flour colour is one of the most important factors in the quality of noodle (Miskelly, 1984). Miskelly and Moss (1985) reported that flour protein content is negatively correlated with white noodle brightness and that high Protein content is associated with increased greyness. Jun *et al.* (1998) found that noodle colour is influenced more by protein than by ash content. Fig. 1 represents the Spider web plot of the sensory attributes of colour, starchy mouth coating, firmness, stickiness and smoothness of the cooked samples of noodles. There was no significant difference ($p > 0.05$) in the colour, starchy mouth coating, stickiness, firmness and smoothness of both cooked experimental noodles samples produced from organic plantain flours. However, when compared to the two branded commercial noodles, branded noodles 1 and branded noodles 2 (BN1 and BN2) respectively, there was significant difference ($p < 0.05$) in all the described sensory characteristics. In terms of colour, BN1 and BN2 were found to have light yellow

colour (4.1 and 4.2 respectively) while noodles produced from organic flour with 2.5 % xanthan gum (Org2) was grey (3.2) and noodles produced from organic flour with 3.5 % xanthan gum (Org3) was light grey (3.8)
BN1 and BN2 were found to be smooth (4.2) while the experimental noodle samples were observed to be slightly rough (Org3 – 3.8 and Org2 – 3.3). In terms of firmness, all the noodle samples were rated firm (ranging from 3.8 - 4.1) but Org3 was observed to be firmer (4.1) than others. All the samples were rated mildly sticky (4.1-4.4) in terms of stickiness but Org3 was less sticky (4.4) than all the samples. Furthermore, BN1 and BN2 were found to be mildly starchy in mouth coating (4.2 and 4.1 respectively) while Org3 and Org2 had moderate starchy mouth coating quality (3.5 and 3.3).

Descriptive Sensory Attributes of Dry experimental Noodles and Branded Commercial Noodles samples

According to Huang and Morrison (1988), the texture of noodle is a very important assessment of noodle quality. While the Chinese prefer noodle with medium firmness and strong chewiness texture, the Japanese prefer soft texture.

Fig. 2 represents the Spider web plot of the sensory attributes of appearance (degree of shininess), colour, surface smoothness, hardness (texture) and overall acceptability of the dry samples of noodles based on the described sensory characteristics. Significant difference ($p < 0.05$) existed between the dry experimental and commercial branded noodles samples. Appearance ranged from 4.0 – 4.5. BN1 and BN2 were rated slightly shiny (4.5) in appearance, Org3 and Org2 were rated to be slightly dull (4.1 and 4.0 respectively). Colour attribute for the samples of noodles ranged from 3.2 - 4.5. BN1 and BN2 were found to have light yellow colour (4.3 and 4.5) respectively while Org3and Org2 were rated slightly grey (3.8 and 3.2) respectively. BN1 and BN2 were found to have the highest surface smoothness (4.3) while Org3 (3.6) and Org2 (3.2) were slightly rough.
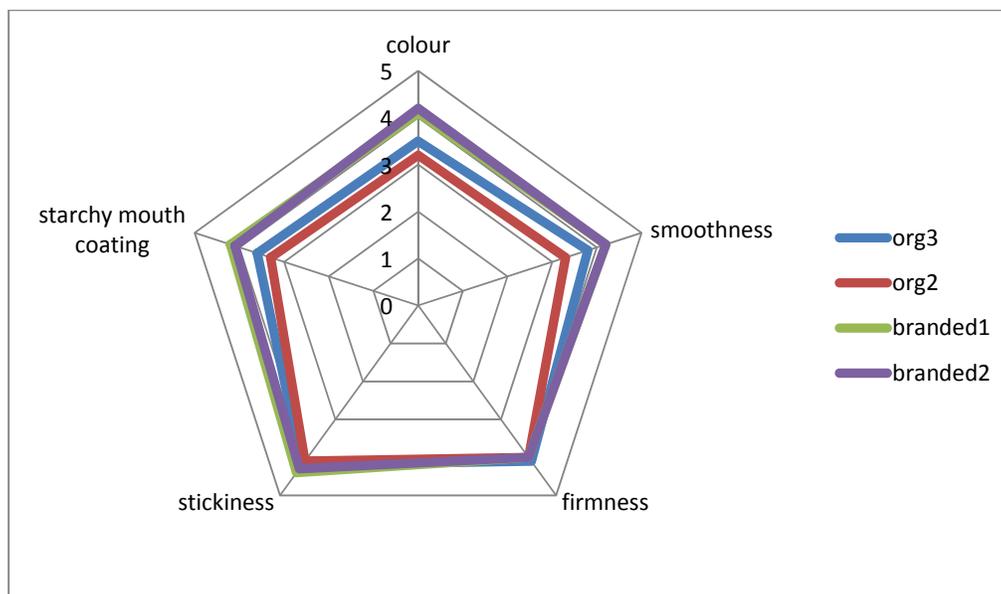
Figure 1. Spider web plot on sensory descriptive profiling of cooked experimental Noodles and Branded Commercial Noodles samples.
Org3: unripe organic plantain noodles with 3.5 % xanthan gum
Org2: unripe organic plantain noodles with 2.5 % xanthan gum
branded1 (BN1): Branded Noodle 1
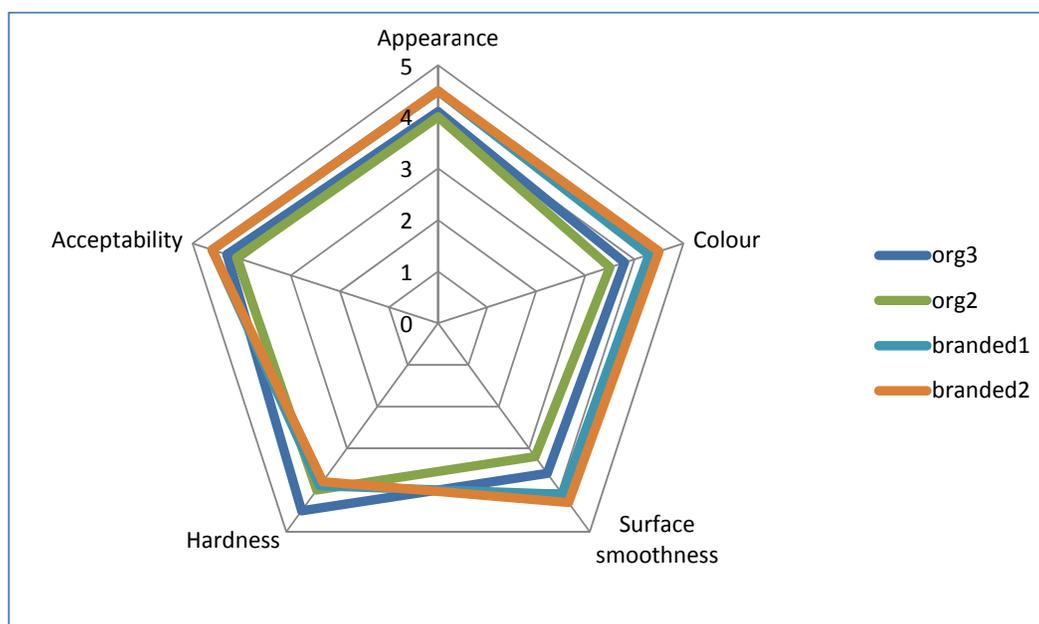branded1 (BN2): Branded Noodle 2

Figure 2. Spider web plot on sensory descriptive profiling of dry experimental Noodles and Branded Commercial Noodles samples.
Org3: unripe organic plantain noodles with 3.5 % xanthan gum
Org2: unripe organic plantain noodles with 2.5 % xanthan gum
branded1 (BN1): Branded Noodle 1
branded1 (BN2): Branded Noodle 2

In terms of hardness, Org3 was rated the hardest (4.5) Org2 (4.0), BN1 (3.9) and BN2 (3.8). Based on these perceived quality attributes of the dry samples of experimental and branded commercial noodles, the acceptability level ranged from 4.0-4.6. All the samples were acceptable. But BN1 and BN2 were more acceptable (4.6) than Org3 (4.3) Org2 (4.0)

The quality of noodles made from rice flour, mung bean flour, tapioca, sweet potato, sorghum and corn flour especially depends on the role of starch, because noodles made from those flours other than wheat do not possess the ability to develop a functional gluten protein network (Suhendro *et al.,* 2000).

Acceptability based on described Sensory Attributes of Cooked experimental Noodles and Branded Commercial Noodles samples.

Fig. 3 represents the Spider web plot of the acceptability level of the sensory attributes of taste, flavour/aroma, texture and colour of samples of cooked noodles. There was significant variation ($p < 0.05$) in almost all the investigated sensory attributes of the cooked experimental and branded commercial samples of noodles. Taste values ranged from (1.3 – 4.7) while Org3 and Org2 exhibited characteristic plantain taste (1.4 and 1.3) respectively, BN1 and BN2 had bland taste (4.7 and 4.6) respectively. Org3 and Org2 had plantain flavour/aroma and rated (1.5) while BN1 and BN2 had characteristic noodle flavour and rated (4.6 and 4.5) respectively. All the noodles were rated between 4.0 – 4.1 texture wise (mildly sticky) but Org3 was most preferred (4.1). The colour values of the cooked noodles ranged from (3.2– 4.2). BN1 and BN2 were found to have light yellow colour (4.1 and 4.2) respectively, Org3 (3.5) while Org2 had the least colour (3.2). Based on these perceived attributes, BN1 and BN2 were more acceptable (4.6) than the experimental noodles samples, Org3 (4.3) and Org2 (4.1).

The reduction in the acceptability of sensory attributes of the dry and cooked experimental samples of noodles in terms of colour and taste may be as a result of the familiarity of panellists with the colour and taste of the branded commercial samples of noodles produced from wheat flour. This is as a result of the extra remark that the colour and taste of the experimental samples of noodles should be improved upon.
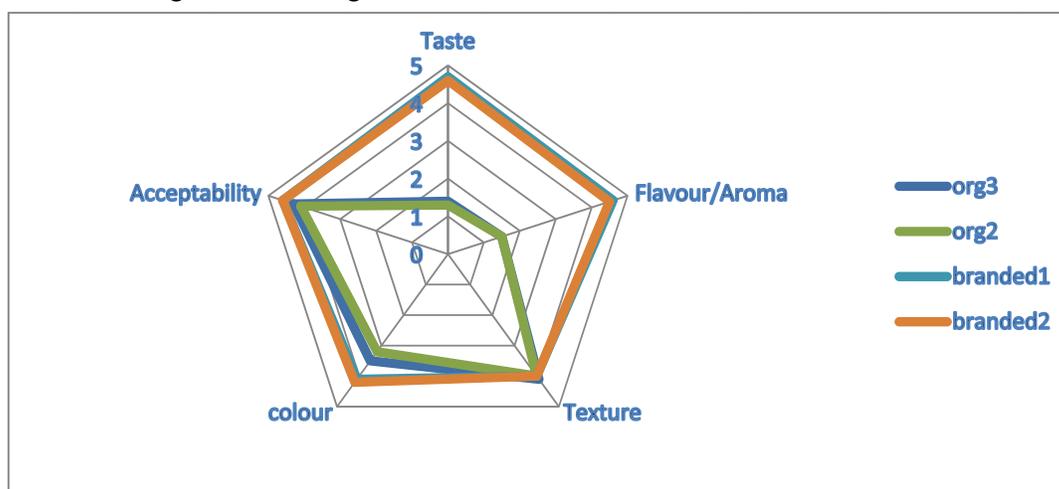

Figure 3. Spider web plot on sensory acceptability levels of cooked unripe organic, inorganic plantain and branded noodles

Org3: unripe organic plantain noodles with 3.5 % xanthan gum
Org2: unripe organic plantain noodles with 2.5 % xanthan gum
branded1 (BN1): Branded Noodle 1
branded1 (BN2): Branded Noodle 2

CONCLUSION

Conclusively, this study showed that gluten-free noodles produced from organic unripe plantain flour with 3.5 % xanthan gum exhibited some properties that compared favourably with the branded commercial wheat flour noodles. Hence, a plantain-flour based gluten-free noodles that possess sensory properties that can compare favourably with wheat-based noodle may be formulated. But the taste and colour should be improved upon and storage stability to determine shelf-life carried out.

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