SPICE ADDITION ENHANCED NUTRITIONAL AND KEEPING QUALITIES OF WHOLE QUALITY PROTEIN MAIZE (QPM) OGI

***Olanipekun, OT[1], Ejigbo, EA[1], Ogunwale. KO[2] and Omolade, OE[2]**

[1] Product Development Program, Institute of Agricultural Research and Training, Obafemi Awolowo University, Nigeria

[2] Department of Family Nutrition and consumer sciences, Faculty of Agriculture, Obafemi Awolowo University, Nigeria

Abstract

Ogi is a popular breakfast meal in Nigeria. It easily deteriorates when kept in ambient condition. The need to extend the keeping quality of ogi, independent of electricity informed this study. Four samples of raw whole ogi were made from quality protein maize (QPM). Three samples were spiced, sample A was spiced with ginger at 5% level, sample B was spiced with clove at 5% level, sample C was spiced with ginger and clove, both at 2.5% level, while sample D served as control and was made from 100% QPM. All samples were kept at ambient temperature. Nutritional and keeping qualities were assessed at days 0, 7 and 14. The AOAC standardised method of analyses was used to determine proximate and mineral content of the samples. Microbial analyses (Total viable count-TVC, Total fungal count –TFC, Lactic acid bacteria count- LABC) and sensory evaluation were also done on the samples on days 0, 7 and 14. Results revealed that addition of spices to whole QPM ogi improved its protein values. The mineral contents of spiced samples were found to be significantly higher ($p<0.05$) than non-spiced sample. Sample A had the highest values of mineral contents during the period of storage (271mg/kg, 199mg/kg, 127mg/kg at days 0, 7 and 14 respectively for calcium). TVC, TFC, LABC were significantly lower ($p<0.05$) in spiced ogi samples. By day 7, TVC for spiced samples A, B, C was (4.55, 5.18, 5.63) x10^3 Cfu/ml in comparison with non-spiced sample D (5.89 x10^3 Cfu/ml). Sensory evaluation result revealed that consumers preferred sample A to other samples regardless of the days of storage. Addition of ginger to QPM ogi at 5% level improved the keeping quality and acceptability of whole QPM ogi.

Key words: Ogi, Quality Protein Maize, Microbial analyses, Spices, keeping quality

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Introduction

Maize is one of the popular food crops produced and consumed in all parts of Nigeria. It is utilized in various ways for man and his animals. In south-western Nigeria, maize is used in preparing staple foods like ogi (maize gruel), eko (maize solid gel), abari (maize steamed pudding), e.t.c. which are traditional breakfast and dinner meals for adults and children. Ogi is a porridge prepared from fermented cereals like maize (*Zea mays*), guinea corn (*Sorghum bicolour*) or millet (*Pennisetum typhodenum*). In Nigeria and other parts of West-Africa, it is a staple food and serves as a weaning food for infants. Ogi also serves as food for the sick or convalescent (Adesokan et al, 2010). The prevalence of malnutrition in Nigeria has been consistently high (Alabi *et al*, 2016). The report of National Demographic and Health Survey of 2013, reported by National Population Commission (2014) revealed that the prevalence of protein energy malnutrition recognised as stunting, underweight and wasting, among Nigerian children less than five years of age was 37%, 29% and 18% respectively. This is as a result of the carbohydrate dense ogi with which these children are weaned and fed. Conventional maize has less than 10% protein; it is also limited in essential amino acids like lysine and tryptophan needed for proper development of infants and children (Kataki and Babu, 2003). Quality Protein Maize was developed to enhance the nutritional status of consumers of conventional maize and maize products. It has been established that QPM is suitable for processing into ogi and eko (Olanipekun et al. (2014) unpublished).

The inconsistent electricity supply in Nigeria has affected the keeping quality of many foods, hence the need for alternative means of keeping foods. Older methods that have been used to improve the keeping quality of food include drying, salting, smoking, pasteurisation, canning and bottling (Odaibo et al., 2013). Some of these preservation techniques e.g. salting and smoking are not suitable for ogi, while others are costly and will not be affordable and practicable at household level. Attempt to preserve ogi by drying has been made in time past, however, the quality of conventionally dried product is often low and not well accepted by consumers, the complaints being that texture, flavour and colour were affected (Osungbaro, 2009). Ladunni et al. (2013) had reported that only 2% of Nigerians live above poverty line, therefore there is the need to consider a preservative method that will be suitable for ogi and affordable for ogi consumers. The choice of whole ogi in this research was borne out of growing advocacy that whole grain food is more nutritious than conventionally processed ones

(Ruston and Derbyshire, 2014). Attempt was also made at reducing drudgery associated with the preparation of ogi.

Spices refer to any dried part of a plant, used for seasoning and flavouring a recipe, but not used as the main ingredient. They are substances majorly extracted from plant that bring out the unique natural taste of cuisines and could be used to change the look of food to make it more attractive in color. They are good sources of food preservative (Kim et al., 2001). Spices are composed of phyto-nutrients, essential oils, antioxidants, minerals and vitamins that are essential for good health. Spices have been an integral part of our food and predate the days of our grand-fathers. Many foods have been successfully preserved with spices (Davide et al., 2016). Studies on the effect of spice addition on the nutritional quality of food are available (Tajkarimi et al., 2010; Bassole and Juliani, 2012). However, no report has been given on the effect of spice addition on nutritional quality of whole QPM ogi.

Materials and Methods

Procurement of materials

QPM maize grains (ILE-1-OB) were obtained from the seed store of the Institute of Agricultural Research and Training, Obafemi Awolowo University. Processing materials were provided by the Product Development Program, Institute of Agricultural Research and Training, Obafemi Awolowo University. Ginger and clove were purchased from a local market in Ile-Ife. Chemicals and Media used were of analytical grade.

Preparation of spices

Ginger and clove were washed in clean water to remove dirt. The ginger corms were sliced thinly (0.2cm thick) and arranged in an oven tray for drying. The washed clove seeds were also arranged in a separate oven tray for drying. Spices were dried in a Gallekhamp drying oven at 50°C for 8 hours. Dried spices were milled into fine powder using a laboratory blender (Binatone BLG 450).

Production of whole QPM Ogi

A modified method of Adesokan et al (2010) was used in the preparation of whole ogi. 1.5 kg of QPM was used for the study. The obtained QPM was winnowed, and washed. The QPM grains were then steeped in clean water and allowed to ferment for 72 hours. Steeping water was decanted and maize grains were wet milled into slurry. The slurry was allowed to settle until clear supernatant was obtained. The supernatant was carefully decanted to get whole QPM ogi paste.

Incorporation of spices into whole QPM Ogi

Whole QPM Ogi was divided into 4 portions. Ginger and clove were incorporated into the ogi paste as in Table 1 below. Each sample of the ogi/spice mixture was thoroughly mixed using Kenwood kitchen mixer (KM 283). Each sample was then packed into a bowl, water was poured on it and the bowl was covered and kept on the kitchen table at ambient temperature. The water was changed every day until the end of the experiment.

Table 1: composite mixture of whole ogi paste and spice

Sample code	Whole QPM ogi paste (g)	Ginger (g)	Clove (g)
A	95	5	0
B	95	0	5
C	95	2.5	2.5
D	100	0	0

Chemical analyses of spiced whole QPM ogi

The proximate analyses of spiced whole QPM ogi were determined by the AOAC (2000) method for protein, fat, fibre and ash. Protein content was determined using the Kjeldahl method, where Nitrogen content of the samples was multiplied by the factor 6.25, fat content was determined by soxhlet extraction, crude fibre was determined gravimetrically, ash was determined by burning off the organic matter of the samples at 500°C in muffle furnace until whitish grey ash was obtained. Carbohydrate was determined by difference, by subtracting the sum percentages of all the nutrients already determined from 100.

Mineral content (Calcium, Zinc, Iron and Copper) were determined by the AOAC (2000) method. Samples were mineralised in a digester block. The mineralised solution was then analysed for the minerals of interest, using a Perkin-Elmer model 300 atomic absorption spectrophotometer, equipped with a deuterium light for background correction.

Microbial analyses

Weekly changes in the microbial population (i.e) the total viable counts (TVC), total fungal counts (TFC) and lactic acid bacteria counts (LABC) were determined as described by Adesokan et al (2010).One gram of each ogi sample was homogenized in 9 ml sterile distilled water and 10 fold serial dilutions were carried out, 1 ml of the last dilution was plated into sterile petri-dishes which hereafter will be called plates. Molten media (de Mann Rogosa and Sharpe Agar (MRS) for LABC; Potato Dextrose Agar (PDA) for TFC; and Nutrient Agar for TVC) were poured into the plates individually, the plates were swirled clockwise and anti clockwise to ensure uniform mixing of the content and allowed to set. After solidifying, the plates were incubated in an incubator at 37°C for 48hr for LABC and TVC, while plates for TFC were incubated for 72 hr. All plates were incubated invertedly and were in triplicate of samples. Classification of isolates was based on the established methods using important biochemical and morphological observations and tests (Ojokoh, 2009).

Sensory evaluation of the whole QPM ogi samples

Ogi samples (A, B, C, D) were made into gruel by pre-mixing the ogi paste with warm water (20:5 w/v). It was mixed well to form a thin and smooth paste. Water was allowed to boil, and then poured into the ogi paste with continuous stirring, till it formed the desired consistency; about 150ml of water was used. The gruel was then covered and allowed to simmer for about five minutes. Whole QPM maize gruel was cooled and freshly served to twenty men panellists who were familiar with maize gruel. Evaluation was done using 9-point hedonic scale where 9 was maximum (like extremely) and 1 was minimum (dislike extremely) (Stone and Sidel, 2004). Samples were scored for colour, appearance, flavour, texture, taste and overall acceptability. The panellists were instructed to rinse their mouth thoroughly with water after tasting any of the samples before proceeding to the next sample. This was done to prevent the taste of the samples from interfering with one another. Sensory evaluation was done on days 0, 7 and 14.

RESULTS

Table 2: Nutrient composition of ogi samples

Sample	Carbohydrate (%)			Crude protein (%)			Crude fat (%)			Crude fibre (%)			Ash (%)		
Day	0	7	14	0	7	14	0	7	14	0	7	14	0	7	14
A	62.67 ±0.03[c]	72.20 ±0.00[c]	59.75 ±0.06[c]	2.56 ±0.03[b]	1.63 ±0.02[a]	2.03 ±0.00[a]	0.69 ±0.06[a]	0.63 ±0.04[b]	0.76 ±0.01[b]	1.15 ±0.02[a]	1.15 ±0.04[a]	1.25 ±0.01[a]	1.05 ±0.01[d]	0.97 ±0.00[d]	0.94 ±0.01[c]
B	54.41 ±0.02[a]	65.32 ±0.02[a]	56.29 ±0.04[b]	4.76 ±0.06[d]	2.45 ±0.01[c]	2.63 ±0.04[c]	1.81 ±0.02[c]	1.22 ±0.00[d]	1.04 ±0.03[d]	1.78 ±0.07[c]	1.19 ±0.07[b]	1.36 ±0.04[b]	0.94 ±0.01[c]	0.85 ±0.06[c]	0.86 ±0.02[b]
C	57.98 ±0.04[b]	65.99 ±0.00[b]	53.48 ±0.04[a]	3.58 ±0.10[c]	2.84 ±0.02[d]	3.15 ±0.01[d]	1.49 ±0.04[b]	1.09 ±0.01[c]	0.87 ±0.01[c]	1.35 ±0.01[b]	1.87 ±0.03[d]	1.53 ±0.01[c]	0.89 ±0.03[b]	0.81 ±0.04[b]	0.81 ±0.01[b]
D	64.71 ±0.03[d]	73.41 ±0.01[d]	60.84 ±0.02[c]	1.89 ±0.03[a]	2.14 ±0.01[b]	2.48 ±0.06[b]	1.49 ±0.03[b]	0.56 ±0.01[a]	0.71 ±0.03[a]	1.35 ±0.03[b]	1.29 ±0.09[c]	1.53 ±0.03[c]	0.78 ±0.06[a]	0.76 ±0.03[a]	0.68 ±0.07[a]

Values are means of 3 determinations ± S.D. Means within the same column with different superscripts are significantly different at $p<0.05$

A= Ogi sample + 5% ginger
B= Ogi sample + 5% clove
C= Ogi sample +2.5% ginger+2.5% clove
D= Ogi sample without spice

Table 2 show the nutrient composition of the ogi samples (days 0, 7, and 14). For all samples, carbohydrate content was increased by day 7 while the values dropped by day 14. On day 7, Sample D (non-spiced ogi) had the highest carbohydrate content (73.65 percent). The values for carbohydrate were highest in all the samples. The protein value of the ogi samples ranged between 1.89 percent in sample D to 4.76 percent in sample B. By day 7; the protein values of all samples had dropped but it increased again by day 14, the spiced samples (A, B, C) had higher protein values than the non-spiced sample (D). The values of crude fat obtained ranged between (0.56 percent and 1.81 percent). Fibre value ranged from 1.15 percent to 1.87 percent, there was no specific trend observed. The ash content of the QPM ogi samples ranged from 0.76 percent to 1.05percent. There was no significant difference ($p>0.05$) between the ash values of spiced samples in comparison to the non-spiced control. However, the ash values of the spiced samples were higher than that of the non-spiced samples.

The mineral contents of the ogi samples are given in Table 3. Generally, the spiced ogi samples (A, B, C) had higher mineral values than the control (D), however there was no regular pattern in the mineral values as days of storage increased. The values for calcium were highest in all ogi samples and ranged between (65.25 - 271.20) mg/kg. Iron values ranged from 8.87mg/kg to 26.84 mg/kg; zinc was found to range between 7.45 mg/kg and 15.99 mg/kg. Copper had the least value among minerals evaluated and ranged between 0.50mg/kg and 2.65mg/kg.

Table 4 gives the sensory evaluation of the ogi samples during the period of storage. The result showed that consumers preferred sample A (ogi with 5% ginger) to other samples, regardless of days of storage. Overall acceptability of sample A was significantly higher ($p<0.05$) than control and other samples.

TVC, TFC, LABC of the ogi samples are given in figures 1, 2 and 3 respectively. The spiced ogi samples showed a remarkable decrease in all parameters assessed, in comparison with the control sample D (non-spiced ogi). The microbial count increased in all the samples by day 7, but decreased by day 14.

Table 3: Mineral content of ogi samples

Sample	Calcium (mg/kg)			Iron (mg/kg)			Zinc (mg/kg)			Copper (mg/kg)		
	Day0	Day7	Day14	Day0	Day7	Day14	Day0	Day7	Day14	Day 0	Day 7	Day 14
A	271.20 ±0.09[d]	199.07 ±0.04[d]	126.75 ±0.06[d]	13.34 ±0.06[d]	26.84 ±0.06[d]	14.83 ±0.04[d]	15.99 ±0.06[d]	10.34 ±0.00[c]	10.48 ±0.03[c]	0.84 ±0.03[d]	2.65 ±0.01[d]	0.92 ±0.00[d]
B	209.29 ±0.07[c]	106.10 ±0.14[c]	97.64 ±0.03[c]	9.58 ±0.03[c]	21.61 ±0.03[b]	12.11 ±0.01[c]	10.62 ±0.03[b]	12.83 ±0.01[d]	13.09 ±0.04[d]	0.74 ±0.01[b]	1.10 ±0.00[c]	0.72 ±0.01[b]
C	102.96 ±0.06[b]	78.80 ±0.11[b]	83.39 ±0.06[b]	9.15 ±0.09[b]	25.08 ±0.10[c]	10.94 ±0.04[b]	10.22 ±0.02[a]	7.48 ±0.01[a]	9.81 ±0.01[b]	0.78 ±0.03[c]	1.04 ±0.01[b]	0.85 ±0.03[c]
D	62.25 ±0.03[a]	66.25 ±0.01[a]	78.58 ±0.03[a]	8.87 ±0.03[a]	18.10 ±0.03[a]	8.96 ±0.03[a]	11.66 ±0.69[c]	7.45 ±0.03[b]	8.72 ±0.03[a]	0.50 ±0.02[a]	0.91 ±0.06[a]	0.69 ±0.02[a]

Values are means of 3 determinations ± S.D. Means within the same column with different superscripts are significantly different at $p<0.05$

A= Ogi sample + 5% ginger

B= Ogi sample + 5% clove

C= Ogi sample +2.5% ginger+2.5% clove

D= Ogi sample without spice

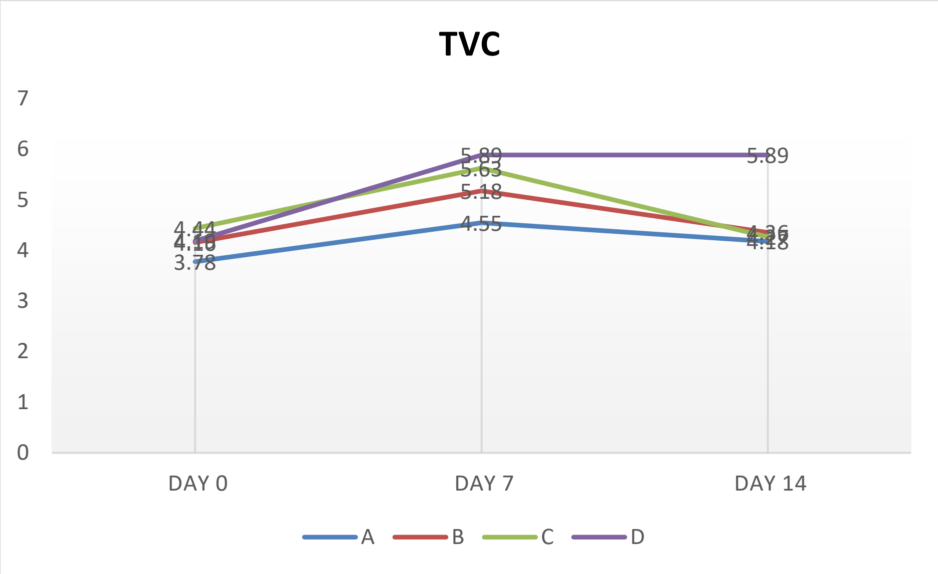

Fig 1: Total Viable Count (TVC) of ogi samples (x10^{3}Cfu/ml).

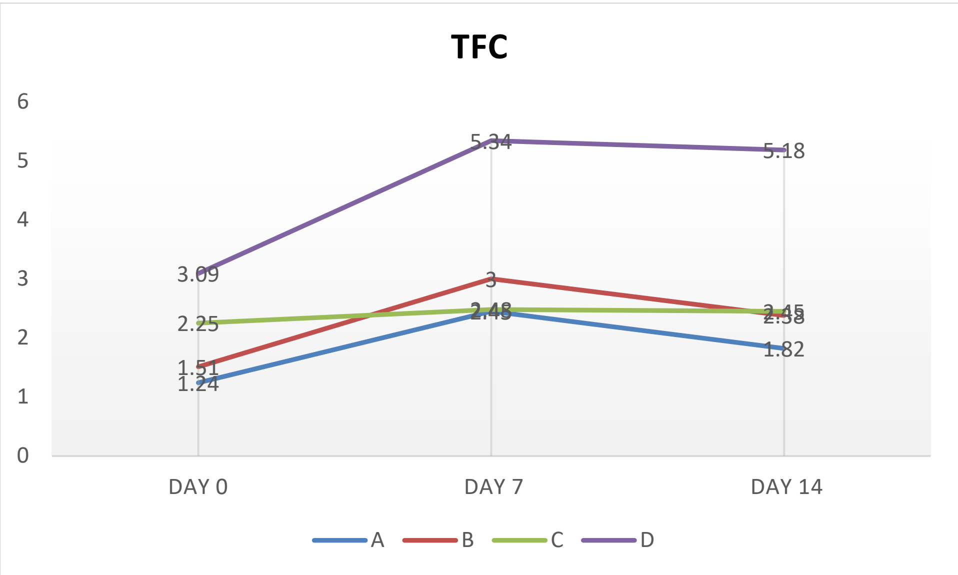

Fig 2: Total Fungal Count (TFC) of ogi samples (x10^{3}Cfu/ml).

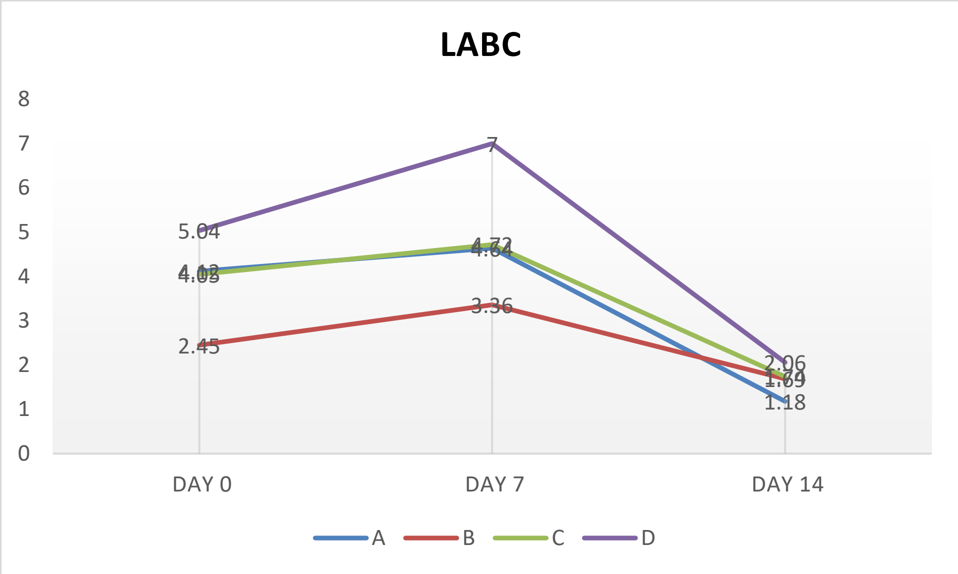

Fig 3: Lactic Acid Bacteria Count (LABC) of ogi samples (x10^{3}Cfu/ml).

DISCUSSIONS

Carbohydrate content of all ogi samples increased by day 7 and dropped by day 14. The initial increase is likely due to the presence of pomace in the ogi samples used for this experiment. It had been reported that ogi residue (pomace) has considerable amount of carbohydrates, although it is abundant in fibre (Abulude et al., 2007). Pomace is usually sifted out of ogi (Adesokan et al, 2010; Farinde, 2015). By the 14th day of storage, fermentation process would have been completed and starch would have been degraded into soluble sugars like glucose, the soluble sugars will be lost through the daily decantation of ogi supernatant (Omidun). Osman (2011) had reported that fermentation activates starch hydrolysing enzymes like alpha amylase and maltase which degrade starch into malto-dextrins and simple sugars like glucose. The high carbohydrate content of all ogi samples was expected because ogi has been documented to be dense in carbohydrate (Omemu, 2011), this implies that whole QPM ogi is a very good source of energy, especially for growing children.

The values obtained for protein on day 0 was least in the non-spiced sample, indicating that the added spices have improved the protein content of the ogi, it has been reported elsewhere that spices play a major role in the nutritional improvement of food (Adesokan et al., 2010). The initial decrease in the protein level of the samples could be due to the breakdown of proteins into peptides and amino acid. Fasoyiro et al. (2009) had explained that protein level usually decreased during fermentation due to the breakdown of the food sample, this was also re-echoed by Pranoto et al., (2013) who reported that fermenting micro-organisms use amino acids thereby lowering the protein content of the fermented food. It has been indicated that some of the micro-organisms responsible for ogi fermentation such as *Entrobacter cloacae* and *Lactobacillus planetarium*, use some amino-acids for growth (Assohoun et al., 2013). The Increase observed on day 14 is as a result of increase in microbial load due to prolonged fermentation as reported by Bibiana et al (2014).

All spiced samples had higher mineral content than the non-spiced sample, this corroborated the finding of Eke-Ejiofor et al (2017) where ogi spiced with ginger, uda and clove had higher values of minerals assessed except sodium. The spices used in this work (ginger and clove) must have improved the mineral content of ogi.

The spiced ogi samples showed a remarkable decrease in the Total Viable count (TVC) and Total Fungal Count (TFC), in comparison with the control sample D (non-spiced ogi). Adesokan *et al* (2010) also observed spiced ogi had lower microbial load. The microbial count increased in all the samples by day 7, but decreased by day 14; the initial increase in microbial load for all samples could be attributed to the warm temperature within the kitchen where the samples were put. Microbial spoilage is enhanced in warm humid environment (Omeire and Nwabunwanne, 2011). The decrease in the microbial count by day 14 may be due to the anti-oxidant and bacteriostatic effect of the spices, as was earlier reported by Quing *et al* (2017). The two spices used in this research (ginger and clove) possess anti-microbial compounds, ginger has gingerol and zingiberol (Davide et al, 2016); while clove has eugenol (Xu *et al.,* 2016).

The initial increase of the Lactic Acid Bacteria Count (LABC) was due to the fermentation process taking place within the ogi samples. Past studies (Oyewole, (1997); Adesokan *et al.* (2010), have implicated Lactic Acid Bacteria (LAB) in the fermentation of ogi. LAB contributes to the flavour and aroma development of ogi.. The reduction in the LABC observed by day 14 indicated that fermentation had stopped by the 14^{th} day. The observed lower values of LABC in the spiced samples (A,B,C) indicated that ginger and clove reduced the rate of action of LAB, confirming the bacteriostatic effect of the spices.

The high preference of consumers for sample A (ogi + 5% ginger) was a confirmation of earlier reports that ginger exerts its flavour into food and enhances consumer acceptance (Ajayi et al., 2017). The authors are of the opinion that the pungent smell of clove contributed to the least acceptance of sample B (ogi + 5% clove). Fermentation is used to enhance the bio accessibility and bio availability of nutrients from different crops including maize. It also improves organoleptic properties as well as extend shelf life of food (Chaves_Lopez et al., 2014).

In conclusion, addition of spices into whole QPM ogi improved the keeping quality at ambient temperature for up to 14 days, however, consumers rated the ogi samples poorly by the 14^{th} day as the taste was reported to have gone bland. We therefore recommend that ginger be added to ogi at 5% inclusion for better keeping quality and the ogi be consumed within 7days (where there is no refrigerator). The surface water of ogi paste should however be changed daily.

Table 4: sensory evaluation of the ogi samples

	colour			**Appearance**			**Flavour**			**Texture**			**Taste**			**Overall acceptability**		
Day	**0**	**7**	**14**	**0**	**7**	**14**	**0**	**7**	**14**	**0**	**7**	**14**	**0**	**7**	**14**	**0**	**7**	**14**
A	7.6^{a}	7.5^{a}	7.7^{a}	7.3^{a}	7.2^{a}	7.2^{a}	7.0^{a}	7.0^{a}	7.0^{a}	6.8^{a}	6.5^{a}	6.5^{a}	8.0^{a}	8.0^{a}	7.8^{a}	7.3^{a}	7.5^{a}	7.8^{a}
B	6.0^{b}	6.0^{c}	5.8^{b}	6.7^{b}	6.5^{b}	6.0^{b}	5.4^{b}	5.0^{b}	5.0^{b}	6.5^{b}	6.2^{a}	6.5^{a}	5.6^{c}	5.0^{c}	5.0^{d}	5.0^{c}	5.2^{d}	5.2^{d}
C	6.6^{ab}	6.5^{b}	6.5^{b}	6.7^{b}	6.5^{b}	6.2^{b}	6.8^{a}	6.5^{ab}	6.6^{ab}	6.5^{b}	6.2^{a}	6.5^{a}	6.4^{bc}	6.5^{bc}	6.4^{c}	6.0^{b}	5.8^{c}	5.5^{c}
D	7.7^{a}	8.0^{a}	7.8^{a}	7.2^{a}	7.2^{a}	7.0^{a}	7.2^{a}	7.0^{a}	7.2^{a}	7.0^{a}	6.8^{a}	6.8^{a}	7.2^{b}	7.0^{b}	7.0^{b}	7.2^{b}	6.5^{b}	7.2^{b}

Values are means of 3 determinations. Means within the same column with different superscripts are significantly different at $p<0.05$

A= Ogi sample + 5% ginger
B= Ogi sample + 5% clove
C= Ogi sample +2.5% ginger+2.5% clove
D= Ogi sample without spice

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