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Fermentation of Corn Starch Powder for the Production of "Ogi"

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Abstract

Ogi was produced by fermenting corn starch powder for 24h and 48h using a seed culture (omidium) as a starter culture. Physicochemical properties such as pH, titratable acidity, viscosity, swelling power solubility, and proximate composition were determined. The sensory properties of the ogi produced was also determined and compared with ogi produced from the traditional method. The results of the proximate analysis showed that the carbohydrate content of sample B(fermented corn starch for 24h) is 78.47% and sample C(fermented corn starch for 48h) is 77.43% were significantly higher ($p<0.05$) when compared to the traditional method-sample A(73.43%).Protein content (10.63%) and fat content (5.10%) of sample A were significantly higher ($p\leq0.05$) than sample B (9.5%) (1.0%) and sample C (9.86%) (1.70%) respectively. The pH of ogi decreased from 5.18 at the beginning of the fermentation to 3.60 at the end of 48h. Whereas the titratable acidity increased from 0.27% to 0.63% after 48h of fermentation. The viscosity of the ogi in the gelatinized state increased as the fermentation period increased from 24h to 48h. There was ignificant ($p\geq0.05$) difference in color, flavor, aroma, taste, sourness, mouth feel and overall acceptability between sample A, C and B. The pH, titratable acidity, textural and sensory properties of ogi produced from corn starch powder that was fermented for 48h were more acceptable than ogi produced through the traditional method and from corn starch powder that was fermented for 24h.

Keywords: ogi, fermentation, titratable acidity, corn starch, viscosity, starter culture

1. Introduction

Fermented foods are among the oldest processed foods, they are of great significance and have formed a traditional part of human diet with a wide diversity of flavors, aromas and texture (Falanaet al, 2011). During fermentation of foods, the controlled actions of selected microorganisms is used to alter the texture of foods, preserve foods by the production of acids and aromas which increase the quality and value of raw materials.

Ogi is an important staple fermented cereal gruel or liquid porridge food made either from maize, sorghum or millet. It is a popular complementary food for infants, breakfast meal for children and adults as well as a meal of choice for the convalescence and the aged (Teniola&Odunfa, 2001; Omermuet al,2007). Ogi is either consumed as a gruel/porridge known as "pap" or as a gel-like product known as "Agidi" in Nigeria. The color of ogi depends on the type of cereal used for its production. White maize produce ogi with cream color, sorghum produce light brown ogi while millet produces greenish to grey color (Banigo& Muller, 1972a).

Traditionally, ogi is produced by soaking maize grains in warm water for 1 to 2 days followed by wet-milling and sieving through screen mesh to remove the bran, hulls and germ while the sieved supernatant is allowed to sediment, fermented for 1 to 2 days to yield a wet cake known as ogi (Akinrele, 1970; Banigo& Muller, 1972a).

Titratable acidity, pH and development of flavor are the biochemical changes that occur during fermentation process. Lactic acid is the predominant organic acid produced during the fermentation which dropped the pH of the ogi to 3.8. Akinrele (1970); Odurafa&Adeyele (1985) observed a correlation between flavor acceptance and titratable acidity in ogi production and concluded that organoleptic evaluation indicate that acidity or sourness is by far the most important attributes for maximum acceptability of ogi. Akinrele (1970) reported that during the first 24h of maize fermentation, corynebacterium species becomes predominant and appear to be responsible for the diastatic activity, hydrolyzing starch glucose and encouraging the growth of lactic acid bacteria and yeast. He

further reported that the activity of corynebacterium species ceases after the first day of fermentation while the activities of lactobacilli and yeast continues beyond the first day of fermentation and concluded that the lactobacilli species produce the lactic acid which depress the pH of the ogi to 3.8.

In an attempt to improve on the traditional method of ogi production, Banigo et al., (1974) developed a new process for making ogi which was found to produce an excellent quality ogi better than the known traditional methods. They dried milled corn into whole corn meal which dehaulled into corn flour and upon addition of water, the mixture was cooked, cooled and then incubated with a mixed starter culture of three organisms comprising of *L. plantarum, S. lactis* and *Saccharcmycesrouxii*.Thus, this method eliminated the need for starch hydrolyzing bacteria and shortens the fermentation time.

Although the wet ogi obtained from the traditional method and the improved method developed by Banigo et al. (1974) produces ogi that have a smooth texture, a sour or acid flavor similar to that of yoghurt and a characteristic aroma that differentiate it from corn starch. Both methods use whole maize grains which are costly and the stability of the wet ogi is a problem militating against large scale production of ogi. The ogi in the wet form in which it is sold to consumers cannot be stored at home for long period without spoilage and this affect the effective mass production and distribution. Therefore, this study is aimed at fermenting corn starch using a modified fermentation method from a seed culture or "omidium" (a supernatant solution of fermented maize mash) as a starter culture. Finally determine the physicochemical and sensory properties of the ogi in order to ascertain the acceptability.

2. Materials and Method

2.1 Materials

Corn starch made by Royal ingredient group (Holland) was obtained from a supermarket in Port Harcourt while whole maize grain was purchased from a local market in Port Harcourt. Seed culture was obtained from the supernatant solution of a previous traditional fermented ogi. All reagents used were collected from the Laboratory of Food Science and Technology Department, Rivers State University and were of analytical grade.

2.2 Method

2.2.1 Ogi Production from Whole Maize Grain (Traditional Method)

Ogi was produced from whole maize grain using traditional method as described in Figure 1A. One kilogram (1kg) of whole white maize grain was cleaned, sorted and soaked in water at room temperature ($28\pm2^{o}C$) for 48h (Banigo& Muller, 1972a; Akingbala et al., 1981). The soaked maize was decanted, wet milled, sieved with a muslin cloth and the filtrate is allowed to sediment and ferment for 24h to yield a wet cake known as "Ogi".

2.2.2 Ogi Production from Corn Starch Powder (Modified Method)

Five hundred gram (500g) of corn starch was weighed each into two separate 500ml beakers and 300ml of clean water was added to each beaker, mixed thoroughly with the corn starch to form slurry. One hundred mills (100ml) of a supernatant solution ("Omidium") obtained from the traditionally fermented ogi was added to the corn starch slurry in each of the beakers as a starter culture. It was mixed thoroughly and one beaker (sample B) was allowed to ferment for 24h and the second beaker (sample C) was allowed to ferment for 48h. At the end of each fermentation cycle, the supernatant was decanted and the wet ogi obtained.

The flow charts for the production of ogi (Traditional and Modified Process) are shown in the Figure 1.

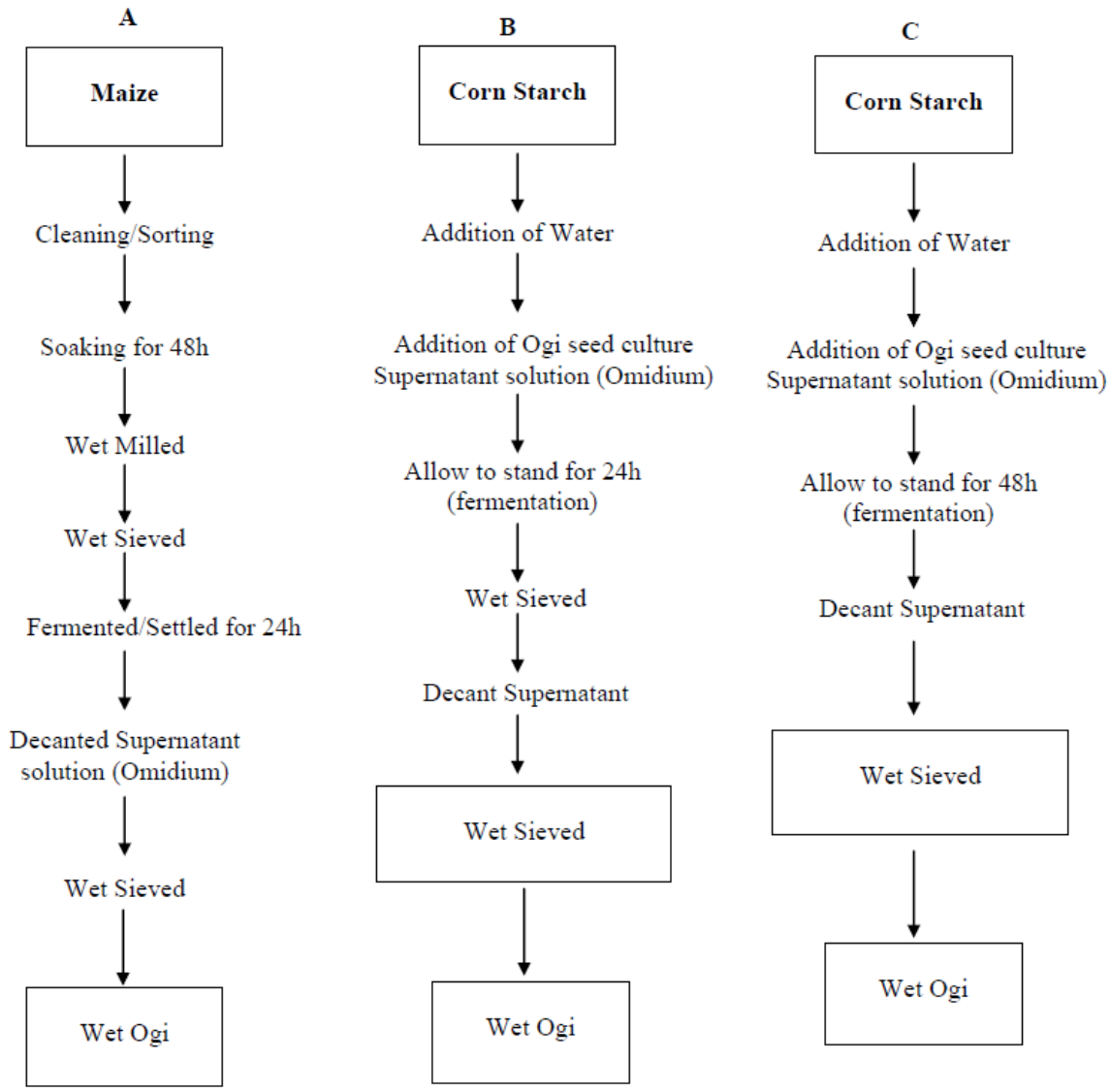

Figure 1. Flow Charts for the Production of Ogi (Traditional and Modified Process)

Key:

A = Traditional method of ogi production

B = Ogi production from corn starch and fermented for 24h using ogi supernatant (modified process).

C = Ogi production from corn starch and fermented for 48h using fresh ogi supernatant (modified process).

2.3 Physicochemical Properties of Ogi

2.3.1 pH Determination

The pH of ogi fermented samples (A, B and C) were determined periodically (0h, 24h and 48h) using a digital pH meter (model pHs 2F – Harris England).

2.3.2 Titratable Acidity Determination

Titratable acidity as lactic acid of fermenting samples (A, B and C) was determined periodically at 0h, 24h and 48h using AOAC (2006) standard method.

2.3.3 Proximate Analysis of Ogi Samples

The proximate analysis of the ogi samples was determined using the AOAC (2006) standard method; moisture

content (method 15.004), total ash (method 14.006), crude fibre (method 7.070), ether extract (method 7.062) and crude protein (method 2.057). The conversion factor N x 6.25 was used for conversion of nitrogen to crude protein. Carbohydrate was determined using the Clegg Anthrone method as described by Osborne &Voogt (1978).

2.4 Determination of Functional Properties of the Ogi

2.4.1 Swelling Power Index

The swelling power index was determined by the method of Takashi &Siech (1988). One gram (1g) of the ogi sample was weighed into a dry clean test tube and 10ml of distilled water was added and was heated in a water bath for 1h at 80^{o}C while the volume was recorded before and after heating. The swelling power index was calculated thus;

$$\text{Swelling power index} = \frac{H_2}{H_1}$$

Where H_1 = Initial height and H_2 = Final height.

2.4.2 Determination of Viscosity

The viscosity of ogi both in the raw (ungelatinized) and wet (gelatinized) state was determined using Rotary Digital Viscometer (Model NDJ – 85 using spindle number 2 at 6rpm.

In the raw state, one hundred mills (100ml) of water were added to 50 grams of ogi in a beaker and the ogi sample was homogenized into slurry and the viscosity was determined using the Rotary digital viscometer.

In the wet state, one hundred mills (100ml) of boiling water (100^{o}C) was added to 50 grams of ogi in a beaker and stirred continuously until it gelatinized, the viscosity of the gelatinized ogi sample was determined using the Rotary digital viscometer and the viscosity was expressed as pa.S.

2.5 Sensory Evaluation of Ogi Samples

Twenty (20) member panelists consisting of staff and students of the Rivers State University was selected based on experience and familiarity with ogi for sensory evaluation. Ogi prepared from corn starch and fermented for 24h (sample B) and 48h (sample C) were compared to ogi prepared from the control (sample A) which is the traditionally fermented ogi. The samples were evaluated for color, aroma, taste, sourness, mouthfeel (smoothness) and overall acceptability. Each attribute was rated on a 9 – point hedonic scale of 1 to 9 with1 representing dislike extremely and 9 representing like extremely as reported by Iwe (2010).

2.6 Statistical Analysis

All experiments and analysis were carried out in triplicates and the means calculated were subjected to analysis of variance (ANOVA) using Statistical Package for Social Science and significance was accepted at 5% ($p \leq 0.05$) level of probability.

3. Results and Discussion

3.1 Functional Properties of the Ogi

3.1.1 pH and Titratable Acidity

Figures 2 and 3 showed the effect of fermentation on the pH and titratable acidity of ogi produced from whole maize grain and fermented for 24h (Sample A) and ogi produced from corn starch that was fermented for 24h and 48h samples B and C, respectively.

The pH decreased from 5.18 at the start of fermentation to 3.60 at the end of 48h fermentation, while the titratable acidity increased from 0.27% at zero hour to 0.59% at the end of 48h fermentation. Akinrele (1970), Banigo& Muller (1972a), all reported similar inverse relationship between pH and titratable acidity in ogi fermentation. The decrease in the pH and increase in the titratable acidity could be attributed to production of lactic acid as a result of predominance of lactic acid bacteria lactobacilli after 24h of fermentation as reported by many researchers (Onyekwere et al, 1989; Adebolu et al, 2007; Falana et al, 2011). Akinrele (1970), Odunfa&Adeyele (1985), Nwokoro&Chukwu (2015) reported that titratable acidity or sourness is by far the most important attributes for maximum acceptance thus fermentation for 48h gave a better titratable acidity.

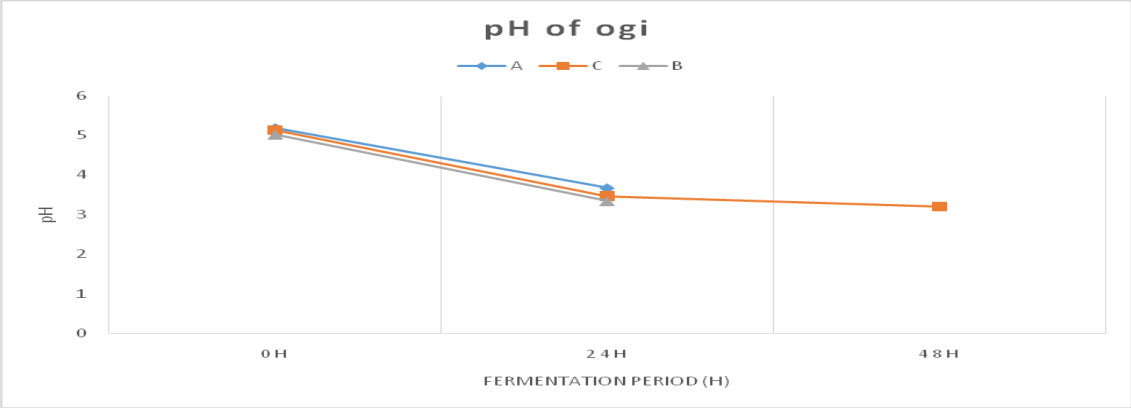

Figure 2. Effect of Fermentation on the pH of Ogi Fermented for 24h and 48h

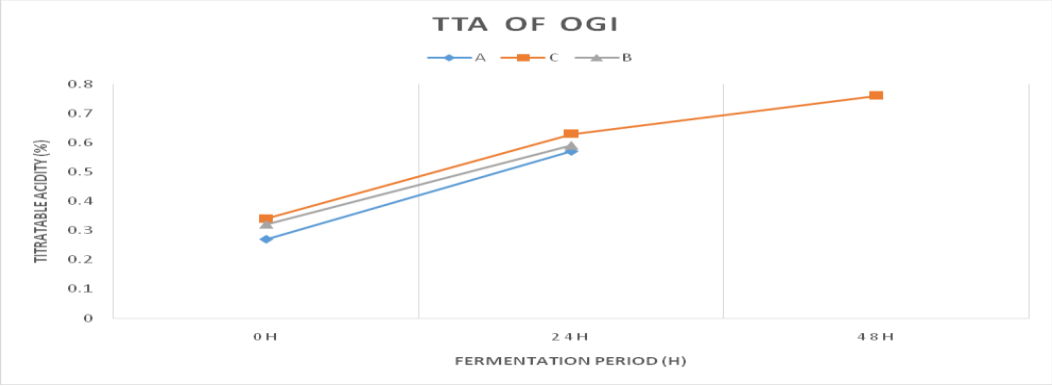

Figure 3. Effect of Fermentation on the Total Titratable Acidity of Ogi Fermented for 24h and 48h

Key:

A = Ogi produced from whole maize grain fermented for 24h

B = Ogi produced from corn starch fermented for 24h

C = Ogi produced from corn starch fermented for 48h

3.1.2 Viscosity and Swelling Power Index of Ogi

Figures 4 and 5 showed the effects of fermentation on the viscosity and swelling power index of ogi in the raw and gelatinized state.In the raw state, the viscosity of ogi decreased with increase in fermentation period from 24h to 48h whereas in the gelatinized state, the viscosity of the ogi increased with increase in fermentation period from 24h to 48h. Adeyemi (1983); Osungbaro (2009) reported increase in viscosity of ogi and gelling tendency as fermentation increases but beyond four days fermentation, the viscosity and swelling tendency decreases. Therefore, fermentation period plays an important role in the textural and sensory properties of ogi, hence the ogi fermented for 48h gave a better viscosity. Osungbaro (1998) reported that beyond four days of fermentation, ogi porridge begins to exhibit poor functional and organoleptic properties.

The study showed that the swelling power increases with increase in fermentation period from 24 to 48h, Adegunwa et al. (2011) reported similar observation. Onitilo et al. (2007) stated that the swelling power of starch granules reflect the extent of the association forces within the starch granules. They further stated that the swelling power of ogi is the thickening characteristics of the ogi and is a function of the ratio of Amylose to Amylopectin fraction of the starch. Banigo et al.(1974); Adeyemi& Beckley (1986) all reported that the swelling characteristics of ogi are influenced by the fermentation period.

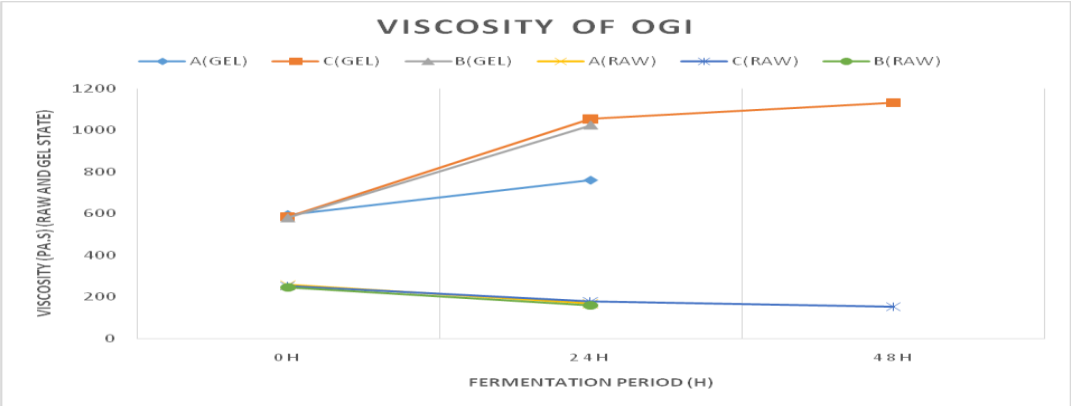

Figure 4. Effect of Fermentation on the Viscosity of Ogi Fermented for 24h and 48h (both Raw and Gel Ogi)

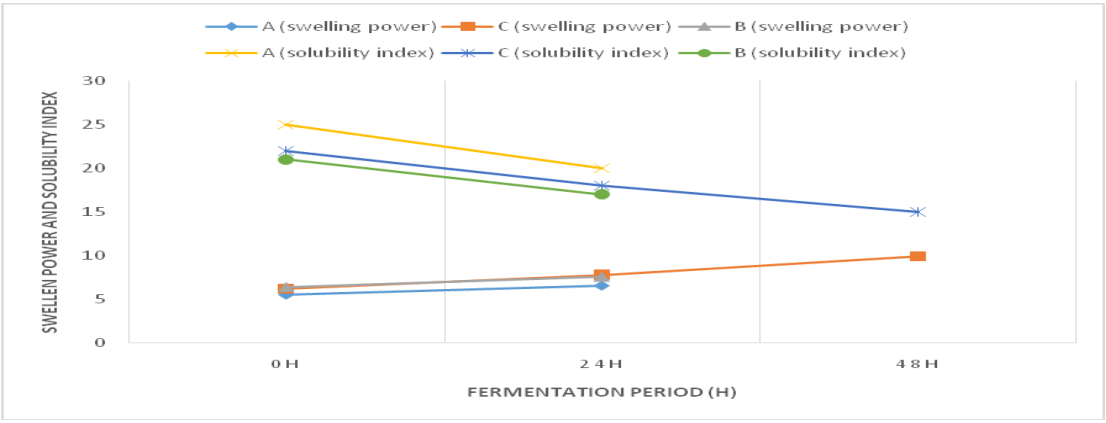

Figure 5. Effect of Fermentation on the Swelling Power and Solubility Index of Ogi Fermented for 24h and 48h

Key:

A= Ogi produced from whole maize grain fermented for 24h

B = Ogi produced from corn starch fermented for 24h

C = Ogi produced from corn starch fermented for 48h

3.2 Proximate Composition of Ogi

Proximate composition of the ogi samples produced by the three fermentation methods A, B and C are presented in Table 1.The carbohydrate content of sample B and C (78.47%) and (77.43%) were significantly higher ($P \leq 0.05$) than sample A. This could be attributed to the fact that sample A was from whole maize grain while sample B and C were from pure corn starch due to maize milling process which produced the corn starch.The protein content of sample A (11.63%) was significantly higher ($P \leq 0.05$) than the protein content of sample B (9.50%) and sample C (9.86%). Again, this is attributed to the fact that sample A was from whole maize grain which contains the germ whereas sample B and C were from pure corn starch that contain only starch and no germ. The same reason is attributed to the fat content. The removal of the germ and aleuron layers during the production of corn starch contributed to the low protein and fat content of the ogi produced from corn starch. This observation is similar to the work of Abdulrahaman&Kolawole (2006). Starch is the major storage carbohydrate of all higher plants and is the major constituents of cereals. However, milling of maize to obtain corn flour (starch) reduces the carbohydrate, protein and fat content of maize (Adeyemi, 1983).

Table 1. Proximate Composition of Ogi Produced from Whole Grain Corn and Corn Starch

Sample	Moisture%	Ash%	Fat%	Protein%	Fibre%	Carbohydrate%
A	8.68^{b}	0.35^{a}	5.10^{a}	11.63^{a}	0.81^{a}	73.43^{b}
B	10.47^{a}	0.30^{a}	1.00^{b}	9.50^{b}	0.26^{b}	78.47^{a}
C	10.52^{a}	0.20^{a}	1.70^{b}	9.86^{b}	0.29^{b}	77.43^{a}

*Mean values with the same superscript within the same column do not differ significantly (P≤ 0.05).

Key:

A= Ogi produced from whole maize grain fermented for 24h

B = Ogi produced from corn starch fermented for 24h

C = Ogi produced from corn starch fermented for 48h

3.3 Sensory Properties of Ogi

Sensory properties of ogi samples produced from whole maize and fermented for 24h (Sample A) and ogi produced from corn starch and fermented for 24h (Sample B) and 48h (Sample C) are shown in Table 2.The result shows that there was a significant (P ≥ 0.05) difference in color, aroma, taste, sourness, mouthfeel (smoothness) and over all acceptability between samples A, B and sample C . However, there was no significant difference (P ≤ 0.05) in aroma, taste, sourness, mouthfeel (smoothness) and overall acceptability between the traditionally prepared ogi (Sample A) and ogi prepared from corn starch and fermented for 24h (Sample B). Aroma and taste constitute the flavor of food products. It has been recognized for centuries that flavor and aroma of fermented foods are as a result of fermentation process they undergo. Akinrele (1970) observed that there is a correlation between flavor, acceptance and titratable acidity in ogi fermentation. Since lactic acid bacteria *lactobacilli spp*predemoninate the ogi fermentation after 24h, it could be the reason why sample C was organoleptically more acceptable than the traditionally prepared ogi sample A and the ogi prepared from corn starch and fermented for 24h (Sample B). Banigo& Muller (1972b) also reported that titratable acidity (sourness) is by far the most important attribute for maximum organoleptic acceptability of ogi, they further stated that desirable flavor and aroma of ogi were achieved at a pH of about 3.6 to 3.7.

Table 2. Sensory Properties of Ogi Produce from Whole Maize and Corn Starch

Sample	Colour	Aroma	Taste	Sourness	Mouthfeel	General Acceptability
A	6.40^{b}	5.50^{b}	6.00^{b}	6.40^{b}	5.70^{b}	5.80^{b}
B	6.60^{b}	5.20^{b}	5.30^{b}	5.90^{b}	5.40^{b}	5.50^{b}
C	7.70^{a}	7.80^{a}	7.50^{a}	7.75^{a}	7.80^{a}	7.00^{a}

*Mean values with the same superscript within the same column do not differ significantly (P≤ 0.05).

Key:

A= Ogi produced from whole maize grain fermented for 24h

B = Ogi produced from corn starch fermented for 24h

C = Ogi produced from corn starch fermented for 48h

4. Conclusion

This study has shown that a more acceptable ogi was produced from the fermentation of corn starch instead of whole maize. Also the corn starch fermentation for up to 48h gave a better aroma and taste than corn starch fermented for 24h. However, the use of whole maize as it is applicable traditionally resulted in higher protein and fat content compared to corn starch.

References

Abdulrahaman, A. A., & Kolawole, O. M. (2006). Traditional preparations and uses of maize in Nigeria. *Ethnobotanical Leaflets, 10*, 219-227.

Adebolu, T. T., Olodum, A. O., & Ihunweze, B. C. (2007). Evaluation of ogi liquor from different grains for antibacterial activities against some common diarrhoeal bacteria in Southwest Nigeria. *African Journal of Biotechnology, 6*(9), 1140-1143.

Adegunwa, M. O., Alamu, E. O., Bakare, H. A., & Godwin, P. O. (2011). Effect of fermentation length and varieties on the qualities of corn starch (ogi) production. *American Journal of Food and Nutrition, 1*(4), 166-170. https://doi.org/10.5251/ajfn.2011.1.4.166.170

Adeyemi, I. A. (1983). Dry-milling of sorgbum for ogi manufacture. *Journal of Cereal Science, 1*(3), 221-227. https://doi.org/10.1016/S0733-5210(83)80024-1

Adeyemi, I. A., & Beckley, O. (1986). Effect of period of maize fermentation and souring on chemical properties

and amylograph pasting viscosity of ogi. *A Nigerian fermented Food, Food Science, 4*(5), 1523-1526. https://doi.org/10.1016/S0733-5210(86)80039-X

Akingbala, J. O., Rooney, L. W., & Faubion, J. M. (1981). A Laboratory procedure for the preparation of ogi, a Nigerian fermented food. *Journal of Food Science, 46*(5), 1523-1526. https://doi.org/10.1111/j.1365-2621.1981.tb04212.x

Akinrele, I. A. (1970). Fermentations studies on maize during preparation of a traditional African starch – cake food. *Journal Science and Agriculture, 21*(12), 619-625. https://doi.org/10.1002/jsfa.2740211205

AOAC (2006). *Association of Official Analytical Chemist*. Official Method of Analysis (18thed.). Washington D.C.

Banigo, E. O. I., & Muller, H. G. (1972a). Manufacture of ogi: a Nigerian fermented cereal porridge: comparative evaluation of corn, sorghum and millet. *Canadian Institute of Food Science and Technology Journal, 5*(4), 217-221. https://doi.org/10.1016/S0315-5463(72)74132-2

Banigo, E. O. I., & Muller, H. G. (1972b). Carboxylic acid patterns in ogi fermentation. *Journal of the Science of Food and Agriculture, 23*(1), 101-111. https://doi.org/10.1002/jsfa.2740230113

Banigo, E. O. I., Deman, J. M., & Duitshaever, C. I. (1974). Utilization of high-lysine corn for the manufacture of ogi using a new, improved processing system. *Cereal Chemistry, 51*(5), 559-72.

Falana, M. B., Bankole, M. O., Omemu, A. M., & Oyewole, O. B. (2011). Microorganisms associated with supernatant solution of fermented maize mash (*omidum*) from two varieties of maize grains. *The Researcher, 3*(7), 1-7.

Iwe, M. O., (2010). *Handbook of Sensory Methods and Analysis*. Nigerian Rejoint Communication Science Ltd., Enugu. Pp. 75-78.

Nwokoro, O., & Chukwu, B. C. (2015). *Microbiological and Biochemical Studies on Akamu: A Traditional Fermented Maize Food*. Proceedings of the 39th Conference and Annual General Meeting of Nigerian Institute of Food Science and Technology (NIFST), Owerri, Nigeria.

Odunfa, S. A., & Adeyele, S. (1985). Microbiological changes during the traditional production of ogi-baba: a West African fermented sorghum gruel. *Journal of Cereal Science, 3*(2), 173-180. https://doi.org/10.1016/S0733-5210(85)80027-8

Omemu, A. M., Oyewole, O. B., & Bankole, M. O. (2007). Significance of yeast in the fermentation of maize for ogi production. *Food Microbiology, 24*(6), 571-576. https://doi.org/10.1016/j.fm.2007.01.006

Onitilo, M. O., Sanni, L. O., Daniel, I., Maziya-Dixon, B., & Dixon, A. (2007). Physico chemical and functional properties of native starches from cassava varieties in Southwest Nigeria. *Journal of Food, Agriculture and Environment, 5*(3&4), 108-114.

Onyekwere, O. O., Akinrele, I. A., & Koleoso, A. O. (1989). *Industrialization of Ogi Fermentation*. In: Stein Kraus, K.H (ed). Industrialization of Indigenous Fermented Foods. Marcel Dekker, New York, 329-362.

Osborne, D. R., & Voogt, P. (1978). *The Analysis of Nutrients in Foods*. London Academic Press, 130-134.

Osungbaro, T. O. (2009). Physical and nutritive properties of fermented cereal foods. *African Journal of Food Science, 3*(2), 023-027.

Osungbaro, T. O. (1998). Effect of Particle Sizes of Wet milled Maize Grains on the Rheological characteristics of ogi, (fermented maize starch gel). *Journal of Tropical for Resources, 14*(1), 102-109.

Teniola, O. D., & Odunfa, S. A. (2001). The effects of processing methods on the level of lysine and methionine and the general acceptability of ogi processed using starter cultures. *International Journal of Food Microbiology, 63*(1-2), 1-9. https://doi.org/10.1016/S0168-1605(00)00321-4