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Research Article
Bacteriological and Proximate Evaluation of Ginger-Fortified Fermented Maize (OGI)

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Abstract

Background and Objective: Fermented cereal food is an important food in human diet globally especially in developing countries. Attempt at fortifying the fermented cereal Ogi with natural substances like ginger becomes imperative. The objective of study was to find out the effect of ginger on the survival rate of Gram-negative bacteria and nutritional content of Ogi. **Materials and Methods:** Typed maize (BR 99 28-SR-Y) sample and ginger were collected for the study. The Ogi was produced following the traditional process and subsequently nutritional and microbial analysis was carried out. **Results:** The value of pH ranged from 4.18-4.36. Moisture content of 10 and 20% ginger fortified Ogi are 60.18 and 60.66%, respectively while control was 71.89%, the crude protein was 2.72-2.65% while control was 1.94%. The value of fat content for the two fortification variables were 1.39 and 1.37% while control was 0.38%. Crude fiber was found to be 0.16 and 0.24% while control was 0.24% but the carbohydrate content was 35.49 and 34.97% compare with the control of 25.62%. Ash content of 10 and 20% ginger fortified Ogi in this study was 0.33% and 0.31 while control was 0.16%. The colony forming units of the bacteria investigated in the fortification ranged from 1.5×10^{3}-3.8×10^{6} CFU mL^{-1} over the period of 15 days designed for the experiment. Twenty four bacteria were isolated and identified which comprises of 5 genera including *Lactobacillus* (50%), *Corynebacterium* (29%), *Escherichia* (8%), *Pseudomonas* (8%) and *Citrobacter* (4%). **Conclusion:** Ogi is a cereal based traditional lactic acid fermented weaning food, which deteriorates after long keeping and ginger has the ability to enhance nutritional content and reduction in the Gram negative bacteria associated with Ogi.

Key words: Ogi, ginger, intervention, microbial load, weaning food

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fortification of traditionally fermented food products is a vital process of increasing the concentration and bioavailability of the nutritional content of the edible part of the plant food especially cereals to the levels that consistently exceed the inherent content[1]. Food fortification has been considered to be a very effective intervention for the prevention of nutritional deficient abnormalities[2]. Ogi was prepared traditionally by steeping cereal such as maize, sorghum, millet in cold water for 3 days (72 h), followed by wet milling and wet sieving through muslin cloth. The filtrate was then allowed to sediment in form of slurry which was the Ogi and the supernatant was discarded to keep the product stable. During steeping and sieving processes of the maize paste, a lot of nutrients including protein, vitamins, minerals are lost[3,4]. However, loss of these nutrients can be reduced eliminating sieving from the production processes. Globally, maize was used for feeding livestock, human consumption and industrial purposes. In most developing country, about 10% of maize, was consumed by human directly as food source, 48% for livestock feeds and the remaining was used for industrial and seed purposes annually[5]. The primary products derived from maize include maize meal and flour. Efforts have been underway in Africa to modify the processing of Ogi with a view to enhance its nutritive value, shelf life and possible therapeutic qualities.

The traditional preparation of maize Ogi involves soaking of maize in water for 3 days followed by wet milling and sieving to remove bran, hulls and germs[6-8]. The pomace was retained on the sieve and later discarded as animal feed while the filtrate settle to yield a semi-solid substance referred to as Ogi in Southwest, Nigeria. It is sour in taste and white starchy sediment[4]. It was an important energy food rich in carbohydrates and traces amount of vitamins, proteins and minerals[9,10]. It also contains natural antioxidants[11].

Spices are herbs with aromatic or pungent flavor. They are dried seeds, fruit, root or vegetable substances used as spice of soups to enhance the flavor[12]. Spices not only excite taste but also composed of high quality phytonutrients, essential oils, antioxidants, minerals and vitamins that are essential for overall health sustenance[13]. Ginger (*Zingiber officinale*) is a spice native of Asia. Ginger is valued for its wide array of medicinal uses. Ginger contains health benefiting oil such as gingerol and zingerone. Ginger is high in antioxidants which help in preventing cell damage caused by free radicals[14]. Fortification of Ogi with legume has been reported by literature but little information was known fortification of Ogi with ginger. Ogi fermented from maize was found to a large extent in the South, West and East and also Northern part of the country[15]. Therefore, the relevance of Ogi fortification became imperative as it is a popular weaning food for children and a staple food for adult in the developing countries like Nigeria. The objective of study was to find out the effect of ginger on the survival rate of Gram negative bacteria and nutritional content of Ogi.

MATERIALS AND METHODS

Sample collection: Typed maize grain (*Zea mays*) (BR 99 28-SR-Y) was obtained from the Institute of Agricultural Research and Training (IAR and T), Ibadan while the ginger (*Zingiber officinale*) was obtained from the local market in Ibadan.

Preparation of fermented maize (Ogi): The samples were weighed into 4 variables with ginger of 5, 10, 15 and 20% which yielded the following fortification variables: 475 g of maize+25 g of ginger, 450 g maize+50 g ginger, 425 g of maize+75 g ginger and 400 g maize+100 g ginger. All sample variables were soaked for 3 days after which they were milled, sieved and was allowed to settle. Control experiment was set up alongside.

Proximate analysis: The proximate analysis of 10 and 20% ginger-fortified Ogi were investigated in the Laboratory of Human Nutrition, College of Medicine, University of Ibadan. Moisture content was determined using air-oven to dry the samples till constant weight was achieved. Protein content was measured by determining the total nitrogen in the sample. Ash content was determined by incinerating the sample in a furnace at 550°C according to guideline of AOAC[16]. The total carbohydrate content (%) in the samples was calculated by difference method.

Hydrogen ion concentration (pH): The pH of Ogi samples were obtained by weighing 5 g of each of the samples and each were suspended into 10 mL of distilled water. The pH of the sample was determined with a pH meter in triplicates according to the method of Ogundeji *et al.*[17].

Bacterial isolation and identification: Sample was serially diluted and then inoculated into Nutrient and MacConkey agar, respectively using pour plating technique. The plates were then incubated at 37°C for 24-48 h[18]. Distinct colonies were randomly selected and then sub-cultured so as to obtain pure cultures. Identification was carried out based on morphological and biochemical properties of the selected

isolates. Gram and spore stains were carried out according to Cheesbrough[19]. Sugar fermentation (i.e., lactose, sucrose and glucose), gas production and hydrogen sulphide test were carried out according to Cheesbrough[19]. Catalase, oxidase, citrate test, methyl-red test and Vogues-Proskauer test.

RESULTS AND DISCUSSION

Proximate analysis of the fortified Ogi: The pH values obtained in this study ranged from 4.18-4.36 in all fortified variables. The proximate analysis of 10 and 20% ginger-fortified Ogi investigated shown that the moisture content of 10 and 20% ginger fortified Ogi are 60.18 and 60.66%, respectively while control was found to be 71.89%, the crude protein was 2.72-2.65% while control was 1.94%. The value of fat content for the two fortification variables were 1.39 and 1.37% while control was 0.38%. Crude fiber was found to be 0.16 and 0.24% while control was 0.24% but the carbohydrate content was 35.49 and 34.97% compare with the control of 25.62%. Ash content of 10 and 20% ginger fortified Ogi in this study was 0.33% and 0.31 while control was 0.16% (Fig. 1).

Microbial association with Ogi: The colony forming units of the bacteria investigated in the fortification for the period of 15 days and the value of colony forming unit per milliliter ranged from 1.5×10^4-3.8×10^6 CFU mL^{-1}. The bacterial was observed slightly low at zero day and slightly increase up to 6th day and drastically reduced at 12th day (Table 1). Twenty four bacteria were isolated and identified in this study. Nineteen isolates were Gram-positive, rod shape bacteria that comprise of 2 genera and only 5 isolates were Gram-negative rod shape bacteria comprise of 3 genera. The proportion of occurrence of the bacterial isolates from the study are *Lactobacillus* sp. (50%), *Corynebacterium* sp. (29%), *Escherichia coli* (8%), *Pseudomonas* sp. (8%) and *Citrobacter* sp. (4%). The bacteria population was observed to be predominantly Gram-positive bacteria comprises of *Lactobacillus* and *Corynebacterium* (Table 2).

Fortification proportion was done at different percentage in 4 variables and bacteria observed were predominantly *Lactobacillus* and *Corynebacterium*.

Effect of fortification of Ogi with ginger (*Zingiber officinale*) on the pH and nutritional compositions: The pH range observed in this study was acidic (4.18-4.36) which similar to report of Wakil and Daodu[20] that there was sharp decline in pH of fermentation of cereal. The low pH possibly account for predominance of lactic acid bacteria in the fermented fortified Ogi. The pH value obtained in this study is similar to pH value reported by Nwachukwu *et al.*[21]. In this study, Ogi was fortified in the proportion of 5, 10, 15 and 20% ginger content. However, nutritional analysis was carried out on 10 and 20% ginger content and it was observed in this study that the moisture content was found reduced most the 20% fortified product which showed the effect of ginger on the Ogi substance. The crude protein in this study was found very high in the 10% fortification which showed the bioavailability of protein in the substance. The carbohydrate and fat in the 10% fortification were very high compare to 20% fortification and

Table 1: Bacterial count in the ginger-fortified Ogi kept at 25±2°C

Sample fortification	Zero day	3rd day	6th day	9th day	12th day	15th day
	(CFU mL^{-1})					
400 g/100 g	2.7×10^6	2.5×10^4	4.0×10^5	1.8×10^6	2.0×10^3	3.8×10^3
450 g/50 g	6.1×10^4	1.0×10^3	3.6×10^6	3.8×10^4	1.5×10^4	1.5×10^4
425 g/75 g	6.7×10^4	1.0×10^5	3.2×10^5	2.8×10^5	1.7×10^3	1.6×10^5
475 g/25 g	5.5×10^3	1.0×10^3	2.1×10^4	1.6×10^5	1.5×10^5	2.6×10^3

Table 2: Proportion of occurrence, morphology, biochemical and sugar fermentation of the bacterial isolates from ginger-fortified Ogi

Bacterial properties	*Lactobacillus* sp.	*Corynebacterium* sp.	*Escherichia coli*	*Pseudomonas* sp.	*Citrobacter* sp.
Proportion of occurrence (%)	50	29	8	8	4
Gram reaction	+	+	-	-	-
Catalase	-	+	+	+	+
Oxidase	-	-	-	+	-
Indole	-	-	+	-	-
Citrate	-	+	-	+	+
Motility	+	-	+	+	-
Starch hydrolysis	-	+	-	-	+
Glucose	+	+	+	-	+
Sucrose	+	+	+	-	+
Lactose	+	+	+	-	+
Mannitol	-	-	+	+	+

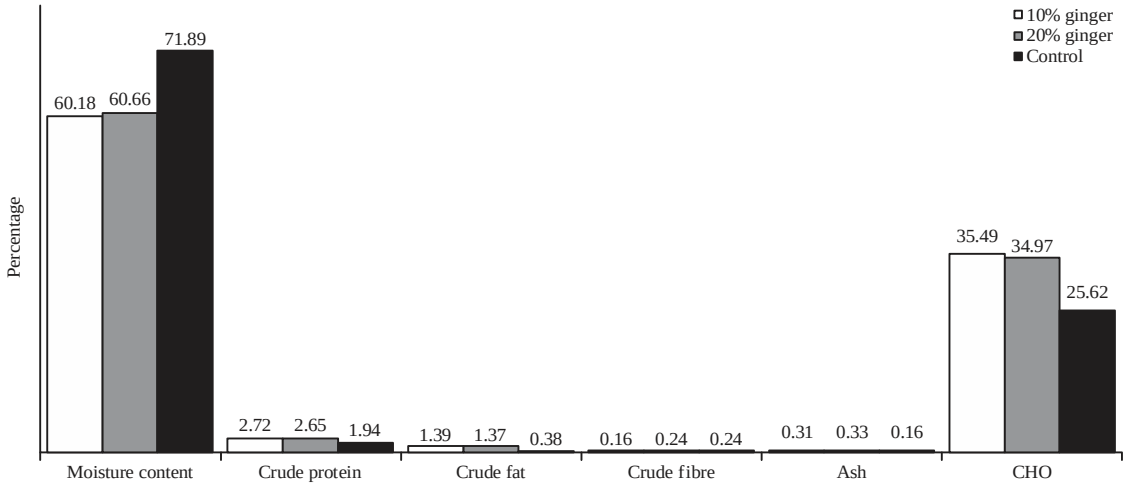

Fig. 1: Proximate analysis of ginger-fortified Ogi kept at 25±2°C for 15 days

control which revealed that fortification of fermented maize cereal Ogi with 10% ginger (*Zingiber officinale*) will go a long way in enhancing the nutritional contents of Ogi as a staple food for weaning and adult. Interest was the low level of fiber and ash content in the 10% fortification as shown in the result which revealed the high level of bioavailability of nutrient in the fortified product. This enhancement and bioavailability of nutrient was similar to report of Farinde [22]. Fortifying Ogi with ginger will help in meeting nutritional and medicinal demands for weaning infants and adult feeding in the developing countries because studies have shown that the infant complementary food was inadequate in protein contents and too watery to meet the nutritional needs of a growing infant which has shown in this study that addition of ginger reduced moisture content.

Effect of fortification of Ogi with ginger (*Zingiber officinale*) on microbial load: The observation in this study was that the microbial load found was moderate low which ranged from 1.5×10^3-3.8×10^6 CFU mL^{-1} similar to report of previous study carried out by Ogodo *et al.*[23], who reported 3.0×10^6 CFU g^{-1} microbial load in yellow maize. Also, it was found that there was very low recovery rate of Gram-negative bacteria in the fortified Ogi which could be associated with the acidic level of the fortified Ogi. Predominantly, the Gram-negative bacteria found in this study are *Escherichia coli*, *Pseudomonas* sp. and *Citrobacter* sp. The recovery rate of lactic acid bacteria (LAB) obtained in this study was very high. Predominantly, *Lactobacillus* sp. had highest proportion which could have been as a result of acidic level of microbial environment within the fortified Ogi product. *Corynebacterium* sp. was second in the proportion of occurrence in this study. This observation is in accordance with Olorunfemi[24], who reported that lactic acid bacteria and some non-pathogenic bacteria are predominantly associated with Ogi. Report of bacteria isolated in this study is similar to Ogodo *et al.*[23], who isolated *Lactobacillus* sp. and *Citrobacter* sp. in the conducted in other part of Nigeria. Fortification of Ogi with ginger will reduce level of contamination and survival rate of Gram-negative bacteria which is similar to report of Adesokan *et al.*[25] that there was low microbial load in the Ogi fortified with ginger Low microbial load and elimination of Gram-negative bacteria indicate the less chance of contacting infection through the consumption of this food. The significant level of lactic acid bacteria like *Lactobacillus* revealed the possibility of ginger-fortified Ogi to function as probiotics in the consumers.

CONCLUSION

Ogi is a cereal based traditional lactic acid fermented weaning food, which deteriorates after long keeping so there is a need to increase the shelf life of Ogi. Spices like ginger has the ability to increase nutritional enhancement of food. This study has showed that Ogi processed from maize could be fortified with ginger to improve the nutrient composition and therefore, reduce occurrence of Gram negative bacteria.

SIGNIFICANCE STATEMENTS

This study discovered that the addition of ginger especially 10% was found desirable in the enhancement of nutritional components like protein, carbohydrate, fat, fibre and notable reduction in the moisture and ash contents of the

fortified Ogi. This finding established the aesthetic value of ginger aside from antimicrobial property that has been reported in the literature. This study was able to establish that the addition of ginger reduced the survival rate of Gram-negative bacteria which ensure the health safety of Ogi consumption. The fortification of Ogi with ginger can help in harnessing the nutritional benefits of Ogi in the developing countries.

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