Effects of Drying Method on Selected Properties of Ogi (Gruel) Prepared from Sorghum (Sorghum vulgare), Millet (Pennisetum glaucum) and Maize (Zea mays)

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Keywords: Foam mat drying; Sorghum; Millet; Maize ogi proximate sensory

Introduction

Ogi is a fermented semi-solid food product manufactured from cereals (commonly maize, sorghum or millet). It is a staple food in most African countries [1], with varying preparation methods and names. It is commonly used as weaning food for babies and also for young children [2] and as a standard breakfast cereal in many homes. Ogi usually has smooth texture and is boiled into porridge called pap or cooked and turned into a stiff gel called “agidi” or “eko” prior to consumption. The color of Ogi depends on the cereal used; slightly cream for white maize, cream for yellow maize, light brown for sorghum and greenish to grey for millet [3]. In Nigeria, the name depends on the locality and the cereal. Ogi processed from maize is simply called “Ogi”, however, it is known as “Ogi-baba” and “Ogi-gero” when sorghum and millet are used respectively [3].

Generally, washing, steeping, milling, sieving, fermentation and drying are the processing steps applied in the preparation of Ogi [3-7]. During processing, nutrients including protein and minerals are lost from the grains thereby affecting nutritional quality adversely [8].

The high moisture content of Ogi slurry predisposes it to spoilage; however the reduction in moisture content through drying can enhance the shelf life, provide convenience and allow for easy reconstitution of the Ogi powder. Foaming, proximate and sensory attributes of foam-mat dried Ogi prepared from sorghum, millet and maize were studied. Each of the cereal mixed with different concentration (5%, 10% and 15%) of foaming agent; glyceryl monostearate (GMS) were whipped and the resulting foam were air dried at 60°C. Cabinet drying was also used to dry the Ogi slurry. The foam densities, proximate and sensory properties were determined using standard methods. Higher foaming agent concentration and longer whipping time resulted in lower foam densities. Foam-mat dried millet Ogi powder had higher foam density than foam-mat dried sorghum and maize Ogi powder. Generally, foam-mat dried Ogi powder had lower moisture content than cabinet dried Ogi, while foam mat dried Ogi had increased fat, protein and ash content with an increase in foaming agent concentration. The crude fiber of the samples varied significantly among the samples while the carbohydrate content decreased with an increase in foaming agent concentration. Freshly prepared Ogi and foam mat dried Ogi powder had comparable sensory attributes but both fresh and foam-mat dried Ogi powder had better sensory properties than cabinet dried samples.

Abstract

Ogi has the tendency to spoil because of its high moisture content, however the reduction in moisture content through drying can enhance the shelf life, provide convenience and allow for easy reconstitution of the Ogi powder. Foaming, proximate and sensory attributes of foam-mat dried Ogi prepared from sorghum, millet and maize were studied. Each of the cereal mixed with different concentration (5%, 10% and 15%) of foaming agent; glyceryl monostearate (GMS) were whipped and the resulting foam were air dried at 60°C. Cabinet drying was also used to dry the Ogi slurry. The foam densities, proximate and sensory properties were determined using standard methods. Higher foaming agent concentration and longer whipping time resulted in lower foam densities. Foam-mat dried millet Ogi powder had higher foam density than foam-mat dried sorghum and maize Ogi powder. Generally, foam-mat dried Ogi powder had lower moisture content than cabinet dried Ogi, while foam mat dried Ogi had increased fat, protein and ash content with an increase in foaming agent concentration. The crude fiber of the samples varied significantly among the samples while the carbohydrate content decreased with an increase in foaming agent concentration. Freshly prepared Ogi and foam mat dried Ogi powder had comparable sensory attributes but both fresh and foam-mat dried Ogi powder had better sensory properties than cabinet dried samples.

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The high moisture content of Ogi slurry predisposes it to spoilage; however the reduction in moisture content through drying can enhance the shelf life, provide convenience and allow for easy reconstitution of the Ogi powder. Although, drying may extend the shelf life of food, it may also impart some undesirable changes in the quality of foods. Literature abounds on several drying techniques used in the food industry for drying foods; spray and drum drying. Aworh reported that cabinet dryer is preferred to drum dryer for drying Ogi at community level because it is less sophisticated and simpler in content and operation.

However, the quality of conventionally dried products is often lower compared to the original material, particularly the color, rehydration ratio, texture, and other characteristics [9]. This could be due to the long exposure of food to heat during drying. Thus, the dehydation time needs to be minimized to avoid loss of nutritional and sensory qualities. The method of foam-mat drying was developed as a result of the desire to increase the rate of drying of liquid and semi-liquid foods. Foam-mat drying involves the incorporation of foaming agent into liquid foods with subsequent whipping to form stiff foam [10]. The foam is then extruded onto a perforated tray and dried in an air stream. In this process, dehydration is rapid, the color and flavor are superior because of minimal heat-damage, the product is a free-flowing powder capable of instant rehydration in cold water, and the process is achieved with minimal cost [10].

A lot of work has been done to investigate the effect of storage on Ogi from maize, millet and sorghum and the rheological properties of Ogi but little or no reports exist on the comparative evaluation of cabinet, and foam-mat drying for preparation of Ogi flour from maize, millet and sorghum. Therefore the effect of different drying methods (cabinet, and foam- mat) on the quality of ogi foam and powder were investigated.

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Materials and Methods

Preparation of Ogi

Maize, sorghum (Red variety) and millet were obtained from local market (Bodija) in Ibadan, Nigeria. Ogi was prepared using improved traditional method of Akingbala et al. [4]. Maize, sorghum and millet were sorted, steeped in tap water for 72hrs. After decanting the steeping water; they were milled in an attrition mill and sieved through a locally manufactured sieve. The slurry was left to ferment for 12hrs before decanting the water. A portion of the sample was dried at 60°C in a cabinet dryer, milled and packaged.

Preparation of Ogi foam using Glyceryl Monostearate (GMS)

Glyceryl Monostearate (GMS) suspension (20%) was prepared by dissolving 20g of GMS in 80ml of hot water at 100°C. The mixture of GMS and hot water were transferred into a blender (Model KM 901D; Kenwood Electronic, Hertfordshire, UK) and blended at maximum speed until a smooth suspension was formed. The required quantity of foaming agent (GMS) suspension was added to Ogi paste at different concentration of 5%, 10% and 15% w/w the mixture was whipped in a Kenwood Chef mixer at maximum speed for 3, 6, 9, 12, 15, 18 and 21 minutes first to ascertain the whipping time for each concentration.

The mixture was finally whipped for 9, 12 and 15mins respectively until homogeous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11]. The foams were extruded on a perforated wire meshes and dried at 60°C in a Cross-flow Gallenkamp until homogenous foam was obtained [11].

Determination of foam density

Foam density of Ogi was determined by filling a standard density bottle of known weight with the Ogi foam and the overall weight of the bottle with the foam was taken. The weight of the density bottle was then subtracted from the overall weight to obtain the weight of the foam.

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\text{Foam density} = \frac{\text{Weight of foam (g)}}{\text{Volume of foam (ml)}}
\]

Proximate composition

Foam mat dried Ogi samples were analyzed for protein, fat, crude fiber ash and moisture using Association of Official Analytical Chemists Method [12]. Analyses were in triplicates. Carbohydrate was calculated by difference.

Sensory evaluation

Sensory evaluation of Ogi was conducted using 9- point hedonic scale by 30 panelist for color, taste, aroma viscosity and overall acceptability [13]. Like extremely and dislike extremely was ranked 9 and 1 respectively.

Statistical analysis

In addition to conducting the experiments in triplicate, all analyses were conducted in triplicates. Mean scores of some of the results and their standard deviation were reported. Data were subjected to analysis of variances, and Duncan multiple range [14] test was used to separate the means.

Results and Discussion

Effect of foaming agent concentration on foam density

The effect of GMS concentration and whipping time on Ogi paste prepared from maize, millet and sorghum are presented in Figures 1-3 respectively. It was observed that as the concentration of the foaming agent increased the foam density of Ogi paste decreased.

Falade et al. [10] and Sankat and Castaigne [15] reported similar trends for cowpea and banana paste respectively. Foam density and volume are parameters commonly used to evaluate whipping properties of paste intended for foam mat drying [16].

Similarly, the foam densities of all the samples decreased as whipping time increased. However, the decrease followed different trend for the various samples (sorghum, millet and maize) used in the production of Ogi powder. The foam density of foam-mat dried sorghum Ogi with 5% and 10% GMS was observed to decrease until after 12 mins when the densities showed an increase. Foam-mat dried sorghum Ogi with 15% GMS showed a similar trend of decrease except for an increase after 15 min. Foam-mat dried millet Ogi irrespective of the GMS concentration showed a decrease in the foam densities.
and increased thereafter before levelling out. A different trend was observed for foam-mat dried maize Ogi powder with the decrease in foam densities showing an increase after 10 min., 7 min. and 15 min for 5%, 10% and 15% GMS respectively. This increase may be due to prolonged whipping. Hart et al. reported that prolonged whipping could cause coarse foam and cause a collapse. Therefore, the whipping time of Ogi paste should not exceed 15 min as increase in foam densities could affect subsequent drying of the foams.

Under similar whipping conditions, foam-mat dried millet Ogi powder had higher foam densities than foam-mat dried sorghum and maize Ogi powder. The difference in the foaming characteristics could be due to compositional differences.

Effect of drying on the proximate composition of Ogi powder

Tables 1-3 below shows the proximate composition of foam-mat dried Ogi powders prepared from maize, millet and sorghum at 5%, 10% and 15% GMS concentrations and cabinet dried sample. Generally, the moisture contents of foam-mat dried (maize, millet and sorghum) Ogi pastes were significantly lower than cabinet dried samples. Similarly, the moisture content of all the samples were lower than values (13.10%) reported for oven dried sorghum Ogi [13] and oven dried maize (9.50%) [8]. This observation shows that foam-mat drying aids the reduction of moisture content to lower values [16] which would further enhance the storability of the dried Ogi powders.

Generally, an increase in the concentration of the foaming agent resulted in an increase in fat, protein and ash content of foam-mat dried Ogi powders. Cabinet dried Ogi powder had lower fat, protein and ash content for all samples. The increase in fat content of foam-mat dried Ogi powders may be attributed to the addition of foaming agent (GMS) which contains fat molecules. The crude fiber content of the samples varied significantly among the samples while the carbohydrate content decreased with an increase in foaming agent concentration.

Sensory evaluation

Data on sensory attributes of fresh and reconstituted Ogi prepared from maize, millet, sorghum, and mixture are as shown in Tables 4-6. Generally, Fresh Ogi pastes prepared from sorghum millet and maize

| Composition | cabinet dried | 5% GMS | 10% GMS | 15% GMS |
|-------------|---------------|--------|---------|---------|
| Moisture    | 8.45          | 7.53   | 6.68    | 7.92    |
| Protein     | 6.14          | 7.12   | 7.44    | 7.77    |
| Crude Fiber | 4.71          | 2.60   | 2.35    | 1.75    |
| Ash         | 0.34          | 0.35   | 0.39    | 0.54    |
| Fat         | 4.68          | 5.74   | 7.30    | 8.31    |
| Carbohydrate| 75.78         | 76.67  | 74.46   | 73.70   |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 1: Proximate composition of Foam-mat dried Ogi from maize.

| Composition | cabinet dried | 5% GMS | 10% GMS | 15% GMS |
|-------------|---------------|--------|---------|---------|
| Moisture    | 7.93          | 7.81   | 7.12    | 7.18    |
| Protein     | 4.73          | 6.13   | 6.46    | 5.80    |
| Crude Fiber | 2.81          | 1.91   | 2.70    | 6.17    |
| Ash         | 0.41          | 0.62   | 0.61    | 0.77    |
| Fat         | 5.17          | 5.61   | 6.64    | 7.15    |
| Carbohydrate| 76.96         | 77.93  | 76.65   | 72.94   |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 2: Proximate composition of Foam-mat dried Ogi from Millet.

| Composition | cabinet dried | 5% GMS | 10% GMS | 15% GMS |
|-------------|---------------|--------|---------|---------|
| Moisture    | 8.90          | 8.24   | 7.29    | 6.06    |
| Protein     | 6.77          | 7.35   | 8.77    | 10.57   |
| Crude Fiber | 3.52          | 2.28   | 4.37    | 4.38    |
| Ash         | 0.54          | 0.56   | 0.66    | 1.03    |
| Fat         | 3.1           | 4.99   | 6.07    | 7.1     |
| Carbohydrate| 77.1          | 74.50  | 75.0    | 70.87   |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 3: Proximate composition of Foam-mat dried Ogi from Sorghum.

| Composition | cabinet dried | 5% GMS | 10% GMS | 15% GMS |
|-------------|---------------|--------|---------|---------|
| Moisture    | 6.6           | 5.36   | 5.9     | 5.8     |
| Taste       | 4.3           | 4.5    | 4.7     | 4.9     |
| Aroma       | 3.8           | 3.5    | 3.9     | 4.7     |
| Overall acceptability | 5.3 | 5.7 | 5.6 | 5.4 |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 4: Mean Sensory Scores of foam-mat dried Ogi prepared from Maize.

| Sensory attribute | Fresh Paste | Cabinet dried | GMS Concentration |
|-------------------|-------------|---------------|-------------------|
| Color             | 4.1         | 5.0           | 4.5               |
| Taste             | 5.0         | 5.3           | 4.6               |
| Aroma             | 4.1         | 4.5           | 4.8               |
| Viscosity         | 3.8         | 6.0           | 5.1               |
| Overall acceptability | 4.9 | 5.5 | 4.9            |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 5: Mean Sensory Scores of foam-mat dried Ogi prepared from Millet.

| Sensory attribute | Fresh Paste | Cabinet dried | GMS Concentration |
|-------------------|-------------|---------------|-------------------|
| Color             | 6.5         | 5.8           | 6.1               |
| Taste             | 6.5         | 5.6           | 4.7               |
| Aroma             | 5.8         | 4.7           | 4.4               |
| Viscosity         | 6.7         | 6.6           | 5.8               |
| Overall acceptability | 6.3 | 5.9 | 5.6            |

Values with the same superscript along the row are not significantly different (p≤0.05).

Table 6: Mean Sensory Scores of foam-mat dried Ogi prepared from Sorghum.
its nutritional value, storability, and mineral content. Also there was significant increase in fat content. With the increase in protein, ash and decrease in moisture observed in Ogi flours, foam-mat drying therefore should be adopted for drying of Ogi pastes. It is therefore recommended that further work on the shelf stability studies and moisture sorption isotherm should be carried out to determine the packaging materials and the shelf life of Ogi flours prepared from maize, millet, sorghum using cabinet and foam-mat drying methods.

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