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Effect of Sweet Potato Starch Addition on the Physico-Chemical and Microbiological Qualities of Stirred Yoghurts

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Abstract- The effect of sweet potato starch addition on the physicochemical and microbiological qualities of stirred yoghurts were studied. The stirred yoghurt was prepared from whole milk powder and other basic ingredients. The product obtained after fermentation was divided into five equal portions and then stabilized by the addition of sweet potato starch at the levels of 10, 15, 20, 25, and 30% to produce different samples of yoghurt. The yoghurts produced were analyzed for physicochemical and microbial qualities using standard methods. The result of the physicochemical properties of the yoghurts showed that the samples had a range of moisture, 77.58-82.62%, crude protein, 5.54-6.96%, fat, 4.08-6.52%, ash, 0.76-1.14%, carbohydrate, 3.12-11.32%, pH, 4.28-4.48, titrable acidity, 0.60-0.86%, total soluble solids, 0.08-0.26% and viscosity, 328-386Cp, respectively. The mean microbial counts of the yoghurts revealed that the total viable count of the samples ranged between 0.9±0. 12 x 10^4 cfu/ml and 1.7±2.2 x 10^4 cfu/ml. The coliform and fungal counts were nil which is an indication of the microbial safety and shelf-stability of the yoghurt samples.

Keywords: *Yoghurt, production, physicochemical, microbial quality, sweet potato starch*

I. INTRODUCTION

Yoghurt is a cultured dairy product used extensively as a health food. Yoghurt is a fermented milk product in which the milk sugar (lactose) is converted into lactic acid by the addition of a characteristic culture of lactic acid - producing bacteria, Lactobacillus bulgaricus and Streptococcus thermophilus. It is the fermentation of lactose (milk sugar) into lactic acid that gives yoghurt its gel-like texture and characteristic tang (Fiszman et al., 2001) Like milk and other fermented milk products, yoghurt is a complete food product, which possesses some biochemical and bacteriological characteristics that make it extremely useful in human diets (Everett and McLeod, 2005). The use of food starches extracted from a wide variety of available and affordable dietary staples such as cereals, roots and tubers in the stabilization of yoghurt has greatly elicited the interest of nutritionists and food scientists in most sub-Saharan African countries in recent times. This is because the starches produced from these staple food crops give body of bulk and improve the texture and nutritional value of yoghurt (Ikenebomeh and Omogbai, 2000). Sweet potato starch is one of the cheapest sources of carbohydrate and beta-carotene yet to be exploited for yoghurt production in Nigeria. The successful utilization of sweet potato starch in the preparation of yoghurt of acceptable quality can lead to economic sustainability and alleviate the problem of protein-energy malnutrition prevent among children and adolescents in most developing nations of the tropics as a result of proverty. The objective of this study is to investigate the effect of sweet potato starch addition on the physicochemical and microbiological qualities of stirred yoghurts.

II. MATERIALS AND METHODS

The whole milk powder, sugar (sucrose), starter culture and sweet potato starch used for this study were procured from Owerri Main Market, Imo State, Nigeria.

III. PREPARATION OF YOGHURTS

The stirred yoghurts were prepared according to the method of Kumar and Mishra (2004). The recipe used for the preparation of the yoghurt contained 100% whole milk powder, 60% potable water, 4% starter culture and 6% sugar (sucrose). During preparation, the whole milk powder was initially prepared into milk solution by dissolving 500 grams of the milk powder with 2 liters of potable water in a plastic bowl. The milk solution obtained was then pasteurized in an electrically heated pot at 65^0C for 30min. During pasteurization, transparent precipitates of scum-curd formed as a result of heat were gradually skimmed off. The pasteurized milk solution was manually stirred with a sterilized stainless steel stirrer for 3 min before being transferred into another plastic bowl. The stirred milk solution was allowed to cool to 43^0C and on cooling, sugar (sucrose) was added and the cooled milk solution was inoculated with the mixed culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (yoghurt starters). The mixture was allowed to ferment in a well-covered plastic bowl at room temperature (30±2^0C) for 12h. After fermentation, the yoghurt produced was cooled in an ice bath placed in a cabinet at 4^0C and stirred. The cooled and stirred yoghurt was divided into five equal portions and then stabilized by the addition of sweet potato starch at the levels of

10, 15, 20, 25 and 30%, respectively. Thereafter, the various samples of stabilized yoghurt obtained were gradually covered and allowed to stand for another 2h, after which, they were stirred thoroughly for 5min. The stirred yoghurts produced were packaged individually in sterilized air tight plastic container and kept in a freezer until needed for analysis. The plain yoghurt was similarly produced and used as reference.

IV. Physicochemical Analysis

The moisture, crude protein, fat and ash contents of the samples were determined in triplicate according to the method of AOAC (2006). Carbohydrate was determined by difference (Ojukuku *et al.,* 2010). The pH, total soluble solids and titrable acidity were determined according to the method of Onwuka (2005). The viscosity was determined with Brookfield viscometer (Model HG2346, Britain, UK) by the method of Odo and Ishiwu (1999).

V. Microbiological Analysis

The total viable count of the yoghurts was determined in duplicate using the pour plate method of Adams and Moss (1999). Two grams of each sample of yoghurt was serially diluted in ten folds. One milliliter of each dilution was plated individually on nutrient agar plate and incubated at 35^0C for 48h. The colony counts were taken in each case with the aid of Gallenkamp electronic colony counter (Model HCD 826G) and the mean values obtained were individually recorded. The above procedure was repeated for coliform and fungal counts except that MacConkey agar was used in place of nutrient agar at 37°C whereas potato dextrose agar was used for fungal count at 28°C for 96h.

VI. Statistical Analysis

The data generated were subjected to Analysis of variance (ANOVA) using statistical package for social science (SPSS version 10.1, 2013) to detect significant differences ($p \leq 0.05$) among the sample means. The Turkey's least significant difference (LSD) test was used where applicable in separating significant means (Okaka, 2010).

VII. RESULTS AND DISCUSSION

The physicochemical properties of yoghurts are presented in Table 1. The moisture content of the samples ranged from 77.58 to 82.62%. Similar levels of moisture have been reported for corn starch stabilized stirred yoghurts (Okoye and Alugwu, 2014). The high moisture content of the samples implies that they could not be stored for a long period without spoilage since this could lead to food spoilage through increased microbial action (Ojukuku *et al.,* 2010). The crude protein content of the yoghurts showed significant ($p \leq 0.05$) variation between the samples. The differences could be due to variation in the level of sweet potato starch added to the products during preparation. Dietary proteins are needed for the synthesis of new cells, enzymes, hormones and other substances required for the maintenance and development of the body (Adebowale *et al.,* 2005). The fat content of the samples which ranged from 4.08 to 6.52% was generally lower than those (6.86-8.84%) reported by Ikenebomeh and Omogbai (2000) for soymilk yoghurts. Fat is important in diets because it promotes the absorption of fat-soluble vitamin (Okaka *et al.,* 2006). The ash content of the yoghurts showed significant ($p \leq 0.05$) difference between the samples. The variation could be attributed to differences in the level of sweet potato starch inclusion in the products. The low ash content recorded by the samples is an indication that they are not good sources of minerals (Hassan *et al.,* 2003). The carbohydrate content of the samples which ranged from 3.12 to 11.32% increased significantly ($p \leq 0.05$) with increased level of sweet potato starch addition to the products. The result, however, indicates that sweet potatoes are good sources of carbohydrate (Enwere, 1998). The pH of the samples ranged from 4.28 to 4.48. The values obtained in this study were similar to those (4.20-4.46) reported by Okoye and Alugwu (2014). The developments of acid and proteolysis during fermentation have been reported to be responsible for the improvement in the flavour of yoghurt (James, 2003). The titrable acidity of the yoghurts showed significant ($p \leq 0.05$) difference between the samples. The differences could be due to variation in the growth of lactic acid producing bacteria during fermentation (Langendorff *et al.,* 2000). The total soluble solids content of the samples which ranged from 0.08 to 0.26% increased significantly ($p \leq 0.05$) with increased level of sweet potato starch inclusion in the products. The observation is in close agreement with the report of Cimander *et al.* (2002) for low fat soy fortified stirred yoghurts. The viscosity of the yoghurts ranged from 328 to 386Cp. The values obtained in this study were lower than those (346-398Cp) reported by Kumar and Mishra (2004) for soy fortified set yoghurt. Generally, the use of sweet potato starch as a stabilizer in the preparation of yoghurt at a level up to 30% enhanced the ash, viscosity and total soluble solids contents of the products.

TABLE I. PHYSICOCHEMICAL PROPERTIES OF YOGHURTS

Samples	Moisture (%)	Crude Protein	Fat (%)	Ash (%)	Carbohydrate (%)	pH	Titrable acidity (%)	Total soluble solids (%)	Viscosity (Cp)
A	82.62^{a}+2.03	6.96^{a}±0.03	6.52^{a}±0.02	0.76^{d}±0.13	3.12^{e}±0.06	4.28^{d}±0.07	0.62^{e}±0.08	0.09^{d}±0.01	328^{f}±3.02
B	82.26^{b}±2.14	6.02^{b}±0.05	5.16^{b}±0.03	0.78^{d}±0.13	5.79^{d}±0.05	4.30^{d}±0.08	0.60^{e}±0.08	0.08^{d}±0.01	334^{e}±3.08
C	79.92^{c}±1.92	5.54^{c}±0.04	4.42^{c}±0.07	0.76^{d}±0.13	9.36^{c}±0.08	4.28^{d}±0.07	0.66^{d}±0.09	0.09^{d}±0.02	356^{d}±3.28
D	78.90^{d}±1.72	5.54^{c}±0.04	4.29^{d}±0.08	0.86^{c}±0.10	10.22^{b}±0.04	4.36^{C}±0.10	0.72^{c}±0,12	0.16^{c}±0.06	368^{c}±3.56
E	78.96^{e}±1.82	5.56^{c}±0.02	4.26^{d}±0.08	1.06^{b}±0.09	10.24^{b}±0.04	4.42^{b}±0.12	0.78^{b}±0.12	0.18^{b}±0.08	374^{b}±3.64
F	77.58^{f}±1.80	5.48^{d}±0.06	4.08^{e}±0.06	1.14^{a}±0.08	11.32^{a}±0.07	4.48^{a}±0.15	0.86^{a}±0.10	0.26^{a}±0.11	386^{a}±3 78

A- Plain or unstabilized yoghurt, B - Yoghurt stabilized with 10% sweet potato starch, C - Yoghurt stabilized with 15% sweet potato starch, D - Yoghurt stabilized with 20% sweet potato starch, E - Yoghurt stabilized with 25% sweet potato starch, F - Yoghurt stabilized with 30% sweet potato starch.

Values are mean ± standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p \leq 0.05$).

TABLE II. MEAN MICROBIAL COUNTS OF YOGHURTS

samples	Total viable count (cfu/ml)	Coliform count (cfu/ml)	Fungal count (cfu/ml)
A	$0.92\pm0.14x10^{4}$	Nil	Nil
B	$0.9\pm0.12x10^{4}$	Nil	Nil
C	$1.1\pm1.18x10^{4}$	Nil	Nil
D	$1.3\pm1.22x10^{4}$	Nil	Nil
E	$1.5\pm1.25x10^{4}$	Nil	Nil
F	$1.7\pm2.2x10^{4}$	Nil	Nil

A – Plain or unstabilized yoghurt, B - Yoghurt stabilized with 10% sweet potato starch, C - Yoghurt stabilized with 15% sweet potato starch, D - Yoghurt stabilized with 20% sweet potato starch, E - Yoghurt stabilized with 25% sweet potato starch, F - Yoghurt stabilized with 30% sweet potato starch.

Table 2 shows the mean microbial counts of the yoghurts. The total viable count of the yoghurts ranged from $0.9\pm0.12x10^{4}$ cfu/ml to $1.7\pm2.2x10^{4}$. The presence of microorganisms observed in the samples could be due to poor sanitary condition and improper handling of the products during preparation. The observation is in consonance with the report of Ehirim *et al.* (2004). Furthermore, the result also showed that the coliform and fungal counts of the samples were nil which is an indication that they are both microbiologically safe and shelf-stable. Generally, the absence of coliform bacteria and fungi in the products coupled with their low total viable count reveal that they are suitable for human consumption and have good keeping quality.

VIII. CONCLUSION

The study showed that the physicochemical and microbial qualities of stirred yoghurts can be greatly improved by the addition of sweet potato starch as a stabilizer during preparation. Furthermore, the observation from the present study also revealed that the incorporation of sweet potato starch in the production of yoghurt at a level up to 30% produced good and acceptable results.

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