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Research Article

Finding a Preservative for Homemade Local Beverages in Northern Ghana: The Case of Sobolo, Tiger Nuts Drink and Zim Kom

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Abstract

In northern Ghana, the most famous and preferred locally made beverages are tiger nuts drink, sobolo and zimkom. The main problem associated with these products however, is their short shelf-life when they are kept at ordinary air/ room temperatures as a result of activities of microorganisms which actions are facilitated by conducive atmosphere of the region. The conducive atmosphere coupled with the 'doomsolization' of Ghana's economy almost every other year during when such beverages are in high demand, further exacerbates the problem of storage losses vendors endear. This has very serious negative financial drain on profits since any unfinished often go waste. Presently large scale production is not possible and therefore these vendors cannot enjoy the economy of scale. To aggravate matters, most vendors lack refrigerators; and even for those who own refrigerators, erratic electricity supplies during the dry periods of the year, encounter significant losses too. It was against this background that this study sought to identify suitable preservative for these homemade local beverages in northern Ghana so that when such a preservative is used the products can be stored under ambient temperatures for an extended period of time. Specifically, the study sought to assess the effects of sodium benzoate on the three beverages; to determine the extent of shelf life extension of the beverages due to the benzoate; to establish which concentration level of the benzoate is most effective; and to determine whether respondents would notice the benzoate in

beverages. The research design employed was quasi-experimental involving the treatment and observation of samples under various handling and/ or storage conditions. Sufficient quantities of each beverage were procured and two varying concentrations of sodium benzoate solutions prepared for use in the experiments. The shelf life observation technique employed was direct where, taste, smell, colour and appearance. Samples without preservatives were set aside as experimental controls. A total of four different experiments were conducted for a period of twenty six (26) days. The major finding was that using sodium benzoate 1.0 g/1000 ml in non-refrigerated tiger nut drink's shelf-life was five (5) days maximum; sobolo lasted 22 days whilst zimkom, 15 days. Sensory evaluations of the samples using untrained consumer panel revealed 100% consumer acceptability. The study recommends a dissemination seminar or workshop to be organised to train the beverage vendors on adopting the use of the sodium benzoate preservative to reduce spoilage losses.

Keywords: Quasi-experimental; Controls; Sensory evaluation; Shelf-life; Preservatives

1. Introduction

1.1 Background to the study

Almost every country across the globe including Ghana has its own local beverages that their citizens enjoy. Most of these beverages may be produced and served within the households in the form of desserts; and times each beverage is believed to have some potential health benefits ascribed to its consumption. Beverages do not only refresh and hydrate the human body but also provides nourishment and contributing to overall nutrition and health [1]. The growing demand for products made from natural raw materials or minimally processed ingredients places a responsibility on processors to identify better ways to make their supply quick and cost-efficient manner. The local beverages in Ghana are mostly produced and sold by street vendors. However, the new emerging trend observed recently in northern Ghana is that, at many of our occasions, e.g. weddings, child naming ceremonies, funerals, etc. local beverages such as sobolo, tiger nuts drink, and zimkom are served instead of the usual carbonated drinks such as Fanta, Coco Cola, Sprite, etc. as was the case in the not so distant past. Not only that, other local cuisines such as nabichinge, a cereal (maize) and legume mix; tuubabni (a steamed bean flour-cassava mixture); nyounbeeka, a variety of steamed leafy vegetables and cereal (maize) grit mixture; are prepared and served to guests [2]. This is an opportune moment for health professionals to ride on and intensify their healthy eating campaigns on dietary renaissance to enhance health and reduce the alarming prevalence of non-communicable diseases such as overweight, diabetes, hypertension, strokes, obesity, and etc. reported in numerous research findings in major cities of Ghana. It is a common observation in most parts of African including Ghana, that cereals are used to produce indigenous fermented foods, both non-alcoholic and alcoholic beverages; the popularity of which beverages are usually based on social, religious or some therapeutic potencies the locales associate with them. Non-alcoholic beverages are consumed by all age groups, whose production methods vary from one region to another, but essentially include malting, brewing and fermentation [3]. The beverages are however most susceptible to spoilage, a major concern to food processors in Ghana and not withstanding their growing popularity, the rapid deteriorative nature of tiger nut drink, sobole, and zimkom is affecting vendors in Tamale.

1.2 Problem statement

Preservatives are part of a broad class of chemical additives often added to food intentionally to delay spoilage. Preservatives inhibit the multiplication of microorganisms, i.e. bacteria, yeasts and moulds. Chemical preservatives are substances which are added to food for purposes of retarding, interrupting or halting altogether microbial activities, e.g. fermentation, putrefaction and decomposition of the food. Besides improving safety and reducing spoilage, preservatives enhance consumer acceptability as well. In northern Ghana, the most popular and preferred of the many locally made drinks are tiger nuts, sobolo and zimkom. However, the challenge associated with these products is their short lifespan (shelf-life) when they are kept under ambient temperatures [4,5]. This has very serious negative financial impact on producers whenever they are unable to sell within 24-hours of production. Consumer acceptability for these drinks wane once they are stored at ambient temperatures beyond 24hours of production. Thus, making large scale production of these beverages, virtually impossible. Another major setback to the local beverage business is the fact that most of the vendors (who are all women) use refrigerators to keep these drinks chilled but most importantly delay spoilage and enhance their safety for human consumption. However, the erratic nature of electricity supply makes storage beyond 24 hours difficult, often resulting in huge spoilage losses. It was on the basis of this background information that the research sought to ascertain preservative potential of sodium benzoate in keeping these homemade local beverages in northern Ghana and improve their storage under ambient temperatures for several days without losing consumer acceptability.

1.3 Objectives

The main objective of the study was to ascertain the preservative potency of sodium benzoate in keeping homemade local beverages in northern Ghana safer for an extended period.

The specific objectives of the study were:

i. To assess the preservative potential of sodium benzoate on the three major locally made drinks in northern Ghana.

ii. To determine how long sodium benzoate can extend the shelf life of the local beverages at ambient temperature.

iii. To ascertain if consumers' would detect the presence of the sodium benzoate preservative in these beverages.

2. Literature Review

2.1 The process of food spoilage, causes and shelf-life

Once harvested and/ or processed and kept in storage, every food commodity albeit plant or animal starts deteriorating ultimately leading to spoilage. Such deteriorative actions once they occur bring about food losses, cause changes in organoleptic appeal (i.e. colour, texture, flavour and taste) and pose health risks to consumers [6-9]. The causes of food spoilage are many, and can be broadly grouped into two as: natural processes inherent in the food and spoilage due to microbes. The physical processes may be due to loss or gain of moisture resulting in loss of nutrients or changes in the form (texture) of food; chemical changes between the constituents of the food, for example water and fats may interact leading to hydrolytic rancidity which may manifest in changes in taste, colour and off-ordours; and deterioration caused by enzymes naturally present in food. Microbial food spoilage is largely caused by growth of yeast, moulds and bacteria, whose metabolic activities in the food especially high sugar or salt content food, for example, fruits and juices which have low pH to go bad. Signs of spoilage caused by yeast include off-odours and flavours and carbon dioxide that may be seen in

swollen food containers. Other strains also spoil wines and other alcoholic beverages by producing gasses, turbidity and off flavours characterised by H2S and acetic acid. Because moulds are obligate aerobes, they barely cause much deterioration to bottled or canned products. However, yeast and bacteria, particularly lactic acid bacteria are largely responsible for spoilage bottled or canned foods [10-13]. Street foods are perceived to be a major public health risk due to lack of basic infrastructure and services, difficulty in controlling the large numbers of street food vending operations because of their diversity, mobility and temporary nature. There are two broad methods of determining shelf-life of food products; they are the direct and indirect methods. The indirect method has four subcategories, and they are a) the challenge test, b) accelerated shelf-life test, c) predictive microbiology and d) survival method. The Direct method employed in this study, deals with real-time studies that consist of storing the product under conditions similar to those that it will actually face, to monitor its evolution at regular intervals of time. This method establishes a more accurate estimation of the time it takes for a product to deteriorate.

2.2 Use of sodium benzoate preservative

Chemical preservatives delay food spoilage by inhibiting growth of microorganisms through a disruption of the microbial cells such as damaging the cell membrane, denaturing important cell proteins or affecting protein synthesis and also interfering and affecting their nucleic acids thus, affecting cell reproduction and growth. Since the three northern beverages generally have relatively high levels of sugar and a low pH, they are suitable target for yeast growth, moulds and some acid-tolerant bacteria. However, absence of oxygen in bottled drinks limits mould growth. Commonly used preservatives include, common salt, sugar, dextrose, spices, vinegar, ascorbic acid, benzoic acid and its salts, SO_2 and the salts of sulphuric acid, nitrates, sorbic acid and its salts, propionic acid and its salts, lactic acid and its salts. Sodium benzoate is most suitable choice of preservative for trial study because it is salt highly soluble in water; it is very potent against yeast and spoilage bacteria and therefore, delays fermentation in juices; and it is commonly used in products which have natural colours such as sobolo. Sodium benzoate (E 211) is the sodium salt of benzoic acid, the chemical name according to IUPAC nomenclature rules being sodium benzoate. It has the molecular formula C7H5NaO2 and molecular weight 144.1 g/mol. Sodium benzoate is a white, crystalline powder or granule with a faint ordour highly soluble (556 g per litre at 20°C) in water. Sodium benzoate is among the benzoates authorised for use as additive in food by the European Union. FDA (2021) sodium benzoate is a salt produced by a neutralization of benzoic acid and any of the following: NaHCO3, NaCO3, or NaOH. It is used against microbial growth in foods and beverages, especially in low acid foods such fruit juices, etc. It is also used as a flavouring agent. The agreed safe levels of its use as a preservative in foods is 0.1 percent. WHO (2000) Sodium benzoate (C7H5O2Na; E 211); molecular weight 144.11) has a melting point above 300 °C. It is very soluble in water (550–630 g/litre at 20 °C) and is hygroscopic at a relative humidity above 50%. Its pH is about 7.5 at a concentration of 10 g/litre water. Benzoic acid and sodium benzoate (see section 4.3.2) are used as preservatives in beverages, fruit products, chemically leavened baked goods, and condiments, preferably in a pH range below 4.5 [14]. A disadvantage is the off-flavour they may impart to foods. Owing to their inhibitory effect on yeast, they cannot be used in yeast-leavened products (Friedman & Greenwald, 1994). Examples of upper concentrations allowed in food are up to 0.1% benzoic acid (USA) and between 0.15%

and 0.25% (other countries). The European Commission limits for benzoic acid and sodium benzoate are 0.015–0.5%. A major market for sodium benzoate is as a preservative in the soft drink industry, as a result of the demand for high-fructose corn syrup in carbonated beverages. Sodium benzoate is also widely used as a preservative in pickles, sauces, and fruit juices. Benzoic acid and sodium benzoate are used as antimicrobial agents in edible coatings. Maximum concentrations reported for benzoic acid or sodium benzoate added to food for preservation purposes were in the range of 2000 mg/kg of food.

2.3 Use of food preservatives and shelf-life

'Shelf life is the period of time, established under intended conditions of distribution, storage, retail and use, that the food would remain safe and suitable'. One possible way to improve shelf-life of beverages is by slowing down their fermentation that is, inhibiting deterioration of the foods and possibly guaranteeing large-scale production and preservation for longer period with maximum retention of its nutritive values. Prescott et al. defined preservatives as a group of chemical compounds deliberately added to food or that appears in food as a result of pre-processing treatment, processing or storage [15]. These include simple organic acids (such as propionic acid, sorbic acid, and benzoic acid), sulphides, and sodium nitrates. The sulphites inhibit yeasts, moulds and bacteria and are most effective as inhibitors of browning in foods. Sulphur dioxide and sulphites have no serious effects in the human system.

3. Methodology

3.1 Study design

The study was conducted using a Quasi-Experimental design. The design sought to establish the effects of sodium benzoate preservative on the three major locally prepared beverages in northern Ghana. An advantage of this design is that, they provide higher external validity than most true experiments, because they often involve real-world intervention instead of laboratory.

3.2 Sample collection and preparation

Sufficient samples of the three major locally prepared beverages: tiger nuts drink, sobolo and zimkom, were randomly purchased from various vendors on the streets and lorry stations in Tamale. Three litres (3,000 ml) of each type of beverage were procured and sodium benzoate (study preservative) which was purchased from Unique Flavours & Fragrances Ltd., one of the major suppliers of ingredients including preservatives in Ghana.

Each bulk beverage sample was divided into three subsamples as follows:

Subsample A: one litre (1000ml) of each beverage type was treated with 1.0g sodium benzoate/1000ml

Subsample B: one litre (1000ml) of each beverage sample treated with 1.5g of the benzoate.

Subsample C: Another litre of each beverage treated with 2.0g of the benzoate.

Subsample D: was used as control, that is, a subsample kept under observation without the preservative (sodium benzoate) in it but under similar environmental conditions to treatment samples so that results can be compared. The varying amounts of the sodium benzoate preservative used was informed by an FDA (2021) guideline recommendation of 0.1% and WHO (2000) of 2000 mg per kg of food.

3.3 Sensory evaluation of samples

The major sensory attributes of the beverages monitored were Taste, Smell, Colour and Appearance using human senses. Because the chemical preservative was most likely to affect the sensory characteristics of the beverages, the study tried to determine whether respondents (potential Consumers')

would be able to detect its presence and at what concentration level. A random sample of 75 untrained sensory test panellists was used to assess the beverages. Each panellist was first given the drinks without the preservative then after cleansing their mouths, a second round of samples with the preservative at 1.0g/1000 ml, a third round at 1.5g/1000 ml and finally a fourth round at 2.0g/1000 ml. They were asked to give feedback after each of the rounds as to whether they noticed any change, slight or major or no change between the subsamples and summaries of the sensory findings are presented in the results section [16,17].

4. Results and Discussion

4.1 Storage analyses of samples

4.1.1. Samples without preservatives (Controls): Results from the observations reveal that, many of the organoleptic characteristics (i.e. smell, taste and appearance) of each control subsample begun showing noticeable changes (deterioration) after 24 hours; by 48 hours in storage, all subsamples showed significant changes in terms of how they tasted. As was to be expected, the zimkom (millet powder drink) in particular tasted sour with some alcoholic smell but both Sobolo and Zimkom retained their colour. After 72 hours of storage, organoleptic characteristics of both zim kom and tiger nuts drink except colour of sobolo, were completely changed and no longer useful keeping for further observation and therefore, were discarded. The findings are in line with already observed fact that these products under ordinary air or room temperature and without preservative do not keep for more than 24 hours and as such affecting incomes of vendors.

4.2 Samples treated with of sodium benzoate 1.0g/1000 ml

After approximately four weeks (26 days) of observation, the data captured on the organoleptic features (colour, smell, taste and appearance) of the beverage samples, showed different levels of deterioration initiated at different times. The tiger nut sample retained all of its usual organoleptic properties for up to 6 days after which signs of deterioration were noticed. By the eighth day it was no longer useful keeping, giving a shelf-life of five days. Zimkom retained its normal features for approximately two weeks (15 days) and showed deteriorative signs after day 16. Sobolo exhibited the longest extension in its shelf-life with a remarkable two weeks (22 days) as signs of noticeable changes began to show in terms of taste by day 23 and was finally discarded on day 26. The study therefore indicates prospects of miximised economic gains for vendors of all three beverages, especially sobolo and zimkom when they use sodium benzoate 1.0g/1000 ml and store at normal room temperatures (20 ºC to 23ºC).

4.3 Samples treated with 1.5g/1000 ml of sodium benzoate

Except for Sobolo which darkened on day 23, the increase in quantity of preservative by 0.50 g did not produce significant results different from those obtained when 1.0 g was used earlier.

4.4 Samples treated with 2.0g/1000 ml of sodium benzoate

Doubling the quantity of preservative from an initial of 1.0 g per 100ml to 2.0 g per 1000l did not produce proportionate increase in shelf-life. The data showed that, in the case of tiger nuts drink not only did the treatment fail to improve shelf-life, the beverage tasted worse after the six days period than in the first experiment when just 1.0 g of preservative was used. Only one day extension in shelf-life was observed about zimkom by doubling the preservative.

Interestingly, sobolo deteriorated sooner than when only 1.0 g was used.

4.5 Sensory evaluation results of beverages containing 1.0g/1000 ml sodium benzoate

The study data shows that, when 1.0 g/1000 ml of benzoate preservative was used, none of the panellist noticed any change regarding any of the sensory features in all the beverage samples. This indicates that any rejection of these beverages by potential consumers is solely attributable to their respective organoleptic characteristics and not that due to the presence of the sodium benzoate preservative.

4.6 Sensory evaluation results of beverages containing 1.5g/1000 ml sodium benzoate

When beverage samples containing 1.50 g/1000 ml of preservative was assessed by the sensory panel, only 2 panellists (2.67%) reported of having noticed a slight change in only the taste of tiger nuts drink. This would have been good news if the increase had resulted in correspondingly high increase in shelf-life of any or all the beverages. Since this was not the case and however, such increases in preservative will only inch up cost of production, it is not worth it.

4.7 Sensory evaluation results for sodium benzoate 2.0g/1000 ml

When the quantity of sodium benzoate was further increased to 2.0g/1000 ml, respectively 2.67% and 1.33% of the panellists said they noticed slight changes in tiger nuts drink taste and odour. Since the increase in quantity of preservative used does not extend shelf-life of the beverages beyond what was observed with the one gram in the original beverage samples, it will not be economically wise applying this finding.

4.8 Summary of findings

The main focus of the study was to establish whether sodium benzoate as preservative can extend the shelf-life of homemade local beverages in northern Ghana stored kept under normal room temperature and at what quantity of the preservative would potential consumers' not notice.

i. The control samples of all the three locally made drinks under ordinary air or room temperature and without preservatives went bad within 24-hours of preservation.

ii. All of the beverage samples treated with the benzoate had their shelf-life extended.

iii. Tiger nuts drink had the shortest extension in shelf-life sobolo had the longest.

iv. The varying amounts of the preservative used made no significant difference in terms of shelf-life extension of products.

v. An insignificant proportion (2.76%) of the panellists could detect any change in the four beverage samples sensory attributes.

vi. Only some minute changes were noticed in the 2.0g/1000 ml samples.

vii. Homemade local beverage vendors, if trained on the use of the sodium benzoate preservative would make a huge positive impact on their businesses.

5. Conclusion

Except for tiger nuts drinks, both sobolo and zimkom beverages had their shelf-life extended significantly and therefore could be used in reducing storage loses beverage vendors currently endear. Increases in the amounts of sodium benzoate preservative beyond the 1 gram per 1000ml beverage sample will not be a wise manufacturing practice since that will only inch up cost of production but not extend shelf-life. Organoleptic characteristics of beverage samples treated with the benzoate preservative is not detectable at a 1 gram per 100ml.

Recommendations

It is recommended that an orientation be organised aimed at disseminating this research findings the implementation of which will enhance incomes of local beverage vendors in northern Ghana.

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