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Characterization of cooked and uncooked home-made ginger beverages produced in Lesotho in comparison with the commercial brand

Mosotho J. George[1], Palesa Lesemane[1], Emmanuel B. Tanor Fidele Tigizimana[2]
[1]Department of Chemistry and Chemical Technology, National University of Lesotho, P.O. Roma 180, Lesotho
[2]Department of Biochemistry, University of Johannesburg, P.O. Box 524, Auckland Park 2006, Johannesburg, South Africa

ABSTRACT

This study reports the results of the assessment of nutritional and non-nutritional properties of both cooked and uncooked home-made ginger beverages produced by one cooperative in Maseru, Lesotho in comparison with one commercial brand obtained from local stores. The cooked ginger beer in general showed reduced contents for most of the parameters analysed: protein content (4.68 ± 0.32 g/100g) than the uncooked counterpart (6.48 ± 0.51 g/100g). The other concern was that the amount of benzoic acid in the home-made samples was almost three times higher than the commercial beer (1.08 - 1.60% compared to 0.35% for commercial sample), as a result needs to be reduced accordingly to the prescribed levels of < 0.1% in the home-made samples before commercialisation. A principal component analysis for the three samples demonstrated considerable degree of spurity among the three samples hence they do not compare well. However, the differences are not significant, hence the home-made juices can be marketed commercially, with the uncooked being the one more preferred and thus recommended.

Keywords: *ginger beer, home-made, commercial brand, Lesotho, principal component analysis.*

I. INTRODUCTION

In response to the low employment rate in Lesotho, many people have resorted to packaging many food stuffs to earn a living. Packaging of traditional beverages has demonstrated a viable venture to most small-scale packagers. Ginger beer is one of such beverages whose consumption is wide-spread in Lesotho both in celebrations and bereavements thereby sparking interest by some people to prepare and bottle these beverages for sale. However, it is still unknown whether this consumption is merely for thirst quenching, taste or for the nutritional value that is well-documented for this beverage.

Ginger is an underground stem or rhizome of the plant *Zingiber officinale* with warm, sweet, strongly aromatic odour and sharp pungent flavour.[1] Ginger has a long use in South Asia, both in dried and fresh form. The Hindu epic Mahabharato written around the 4th century BC describes some meat-stew seasoned with ginger and other spices; while in the Manasollasa literature written in the 11th century AD, ginger was mentioned as flavouring for buttermilk drinks. Its use as a food became much more widespread by the 13th century AD with the advent of Muslim rule in India with its trade reaching almost $200 million in 2009.[2]

It is used as an essential spice in curry powder, ginger bread and can be brewed in boiling water to make ginger beverages such as beers and tea.[3] The taste and pungency of ginger increases with the maturity of the plant, thus young rhizomes are juicy and fleshy with a very mild taste while juice from old rhizomes are extremely potent and sharp. Ginger is often used as a spice in Chinese cuisines.[4] It can be used as ingredient in soups, candies or used as flavouring for cookies, crackers and cake.[5]

Ginger has been reported to contain 0.25 - 3.3% (usually 1–3%) volatile oil; pungent principles (gingerols and shogaols); glycosides of geraniol and gingerdiol; about 6 - 8% lipids composed of triglycerides, phosphatidic acid, lecithins, free fatty acids (lauric, palmitic, stearic, oleic, linoleic, etc.), gingerglycolipids, and others; protein (9%); starch (up to 50%); vitamins (especially niacin and A); minerals; amino acids; gingesulfonic acid, resins; and others.[6]

Ginger has many health benefits some of which are discussed herein. It is claimed to help against ailments such as: nausea and vomiting (antiemetic) during motion sickness and sea-sickness[7] and in post-operative patients,[8] possesses central and peripheral anti cholinergic and antihistaminic effects;[9] *hyper emesis gravid arum* (serious cases of "morning sickness"), especially during the first trimester of pregnancy.[10,11] It is also reported to stimulate appetite and to promote digestion and as an anti-flatulence or carminative to reduce gas and bloating; [12,13] temporary relief and protection against gastrointestinal ulcers,[13] improves blood circulation and lowers blood glucose in the treatment of diabetes.[14]

This report presents the analysis and assessment of nutritional and non-nutritional properties of both cooked and uncooked ginger beverages produced by Sekhutlong Farmers Association, a home-based cooperative in Maseru, Lesotho for baseline information gathering in order to advise the cooperative about the product's fit for purpose. With only few brands of ginger beverages available commercially in Lesotho, and the fact that

these are imported from South Africa (the only neighbouring country), this presents a considerable potential for market for these ginger beverages packaging as a business venture for small-holder producers. A principal component analysis was used to provide a global and qualitative visual representation of similarity or dissimilarity between and within the three samples.

II. MATERIALS AND METHODS

Sample collection and storage

Samples of cooked and uncooked ginger drinks were collected from the Sekhutlong Farmers Association in packaging bottles used for marketing. The commercial sample was obtained from the local store. These samples were stored in the refrigerator 5 °C till further use.

Analysis methods for physical and nutritional parameters

Total crude protein analysis was carried out using Kjeldhal method.[15] Carbohydrate content was analysed by phenol sulphuric acid method.[16] Fat content was analysed by extraction using petroleum ether.[17] Fibre content was analysed by incineration.[18] To determine the energy of the drinks, the amount of carbohydrates, fat and protein were multiplied by their respective standard calorific factors. Total acidity, sodium benzoate, soluble solids, pH, total solids and moisture content were analysed by classical chemistry methods. The ash content was analysed by incineration.[19,20]

Comparison of the samples using principal component analysis

The data matrix obtained from the analyses was exported into the SIMCA 13.0 Software (Umetrics, Umea Sweden) for PCA modelling. The quality of the PCA models was evaluated based on model diagnostic tools such as (i) the cumulative modelled variation in matrix X, R^2X (*cum*) (known also as the goodness-of-fit parameter) and (ii) the predictive ability parameter, Q^2 (*cum*): the fraction of the total variation of matrix X that can be predicted by the extracted components. A four-component model was computed that explained 99.9% of the variance in the matrix X [R^2X (cum) of 0.999] with the accuracy of prediction [Q^2 (cum)] of 0.996.

III. RESULTS AND DISCUSSIONS

Determination of nutritional content of the three samples

The results for nutritional properties analysed for cooked, uncooked and Royalty ginger beverages are shown in Table 1.

Table 1. Nutritional properties of cooked, uncooked and commercial Royalty ginger beer

Parameter	Cooked beer	Uncooked beer	Royalty beer
Crude Proteins (g/100g)	4.69 ± 0.32	6.48 ± 0.51	8.51 ± 0.17
Carbohydrates (mg/100ml)	3.38 ± 0.06	3.38 ± 0.06	0.083 ± 0.034
Fat (g/100ml)	undetectable	undetectable	undetectable
Fibre (g/100ml)	undetectable	undetectable	undetectable
Energy (kcal/100ml)	34.0	41.3	44.3

Values are means of four determinations; the confidence intervals were calculated at p = 0.05.

The crude protein content of the commercial brand (Royalty beer) was highest (8.51 ± 0.17 g/100g) with the cooked ginger drink was the lowest (4.69 ± 0.32 g/100g). However, the obtained value was considerably different from that written on the nutritional information label (less than 0.1 g/100ml). Since this value does not show any confidence interval it makes the value a little dubious analytically. Usually fruits and vegetables do not have significant levels of proteins, which make the uncooked juice a very good component of a routine diet as a juice and a protein source albeit not as high as those foods classified as protein-rich such as meat and milk whose values are an order of magnitude higher. For cooked ginger beverage the low protein content obtained may be attributed to the effect of heating process during cooking. Boiling process reportedly reduces the

amounts of nitrates and these are measured in terms of total nitrogen just like proteins, thus could explain the observation of reduced proteins after boiling the ginger beverage.[21]

Average concentration of carbohydrates for cooked ginger and uncooked ginger were both found to be 3.38 ± 0.06 mg/100ml while for Royalty ginger beer was found to be 82.94 ± 0.34 µg/100ml. The value of the commercial Royalty beer agrees with the label although the value in non-committal (<0.1 g/100ml). Since fruits and vegetables do not have significant levels of carbohydrates, the results are satisfactory. The same is true for the undetectable levels of fats. The fibre level was also insignificant in all the samples. The label on the commercial beer stated that the amount of fibre is 0.1 g/100ml. Ginger is reported to have low fibre content, so this is not surprising that it was not detectable.

The energy content for cooked ginger drink, uncooked ginger drink and Royalty ginger beer were found to be 34.0, 41.3 and 44.3 kcal/100ml respectively. From the results, it seems the uncooked ginger beverage provides more energy than cooked ginger beverage. The comparison of the uncooked and the commercial ginger beers seemed to be the same at p = 0.05.

Determination of non-nutritional properties of the ginger beers

Table 2 shows the results obtained in the analysis of non-nutritional properties of cooked, uncooked beverages and Royalty ginger beer.

Table 2. Non-nutritional properties of cooked, uncooked and Royalty ginger beers

Parameter	Cooked beer	Uncooked beer	Royalty beer
Sodium benzoate (%)	1.62 ± 0.01	1.08 ± 0.01	-
Total acidity (%)	0.52 ± 0.01	0.21 ± 0.01	2.04 ± 0.02
pH	2.67 ± 0.04	2.61 ± 0.01	1.61 ± 0.01
Soluble solids (°Brix)	54.98 ± 0.65	54.93 ± 0.94	50.38 ± 0.28
Total solids (%)	24 ± 0.98	12.99 ± 0.29	0.27 ± 0.03
Moisture content (%)	75.01 ± 0.65	87.01 ± 0.72	99.73 ± 0.03
Ash content (%)	2.580 ± 0.220	0.022 ± 0.004	0.160 ± 0.010

Values are means of four determinations with confidence interval calculated at p = 0.05.

The percentage sodium benzoate for cooked and uncooked ginger beers were found to be 1.62 ± 0.01% and 1.08 ± 0.01% which were higher than the prescribed limit of less than 0.1%.[22] Whereas this may not be a problem, this content still needs to be reduced to the acceptable levels for fear of the increased levels of sodium ions, as well as affecting the taste of the juice since sodium benzoate is hydrolysed to benzoic acid in aqueous medium leading to slightly basic conditions. The amount of sodium benzoate in the Royalty ginger beverage was not determined because potassium sorbate was used as preservative instead of the benzoate salt.

Total acidity of cooked ginger drink and uncooked ginger drinks were found to be 0.52% and 0.21% respectively. The obtained value for uncooked ginger drink is below the prescribed range of total acidity which is 0.39 - 1.1%,[23] whereas that of cooked ginger drink agrees well with the prescribed range. The difference might have been caused by addition of less citric acid in the uncooked ginger drink. Again cooked ginger and uncooked ginger drinks were not prepared on the same day, so maybe measurements of citric acid were not the same since the preparation did not adhere to gravimetric measurements but rather using kitchen utensils. Citric acid content should be increased so that it falls in the prescribed range. For the commercial beer, total acidity was found to be 2.04% which is above the prescribed range and this may be due to the reagents added.

The pH values were found to be 2.67, 2.61 and 1.61 for cooked ginger drink, uncooked ginger drink and Royalty ginger beer respectively. The pH values are relatively lower than 4.20 obtained for most non-alcoholic beverages such as pineapple, orange and pawpaw juices.[24] A shift towards much lower acidity skews the acid-alkaline balance and leads to a greater risk of developing osteoporosis, weak muscles, heart disease, diabetes, kidney disease and a host of other health problems.[25] Acidity has a profound effect on the growth of microorganisms. Most bacteria grow best at about pH 7 and grow poorly or not at all

below pH 4.[26] The ingredients used may have effect on the pH of the drinks which makes them to be relatively low.

The average soluble solids were found to be between 54.98 and 50.38 °Brix. These are much higher than those found for pawpaw-red ginger mixed drink, which ranges between 5 and 11 °Brix. The soluble solids for the home-made drinks are found to be acceptable because they are somehow around that of Royalty ginger beer which was used as a reference. The total solids for cooked ginger drink was double that of uncooked ginger drink with 24.98 and 12.99 % respectively while the commercial brand was much lower at 0.27 respectively. The values for uncooked juice compare well with those reported elsewhere averaging 12%.[23] The higher content of these solids could also provide a full feeling which can be a benefit for people that want to lose weight.

The moisture content for cooked ginger drink was found to range cooked < uncooked < commercial juice. The high moisture content makes beverage more suitable as a refreshing and quench-thirsting product which is characteristic of good beverage.[27] The moisture content depends on the total solids, so if the total solids are acceptable, so is the moisture content. Regarding the ash content, the uncooked juice had the highest content at 2.58% with the commercial brand having the least amount at 0.16 %. This is consistent with the total dissolved solids and moisture content respectively. Ash contents of fresh foods rarely exceed 5%, although some processed foods can have ash contents as high as 12%.[28]

Comparison of the samples using principal component analysis

A scores scatter plot (Fig. 1) was constructed from PC1 and PC2 [R^2X (cum) of 0.934, Q^2 (cum) of 0.996 and 95% confidence] and explains 99.0% of the variation, and shows samples differentially clustered into different groups (cooked uncooked and commercial) with minimal within-group variation.

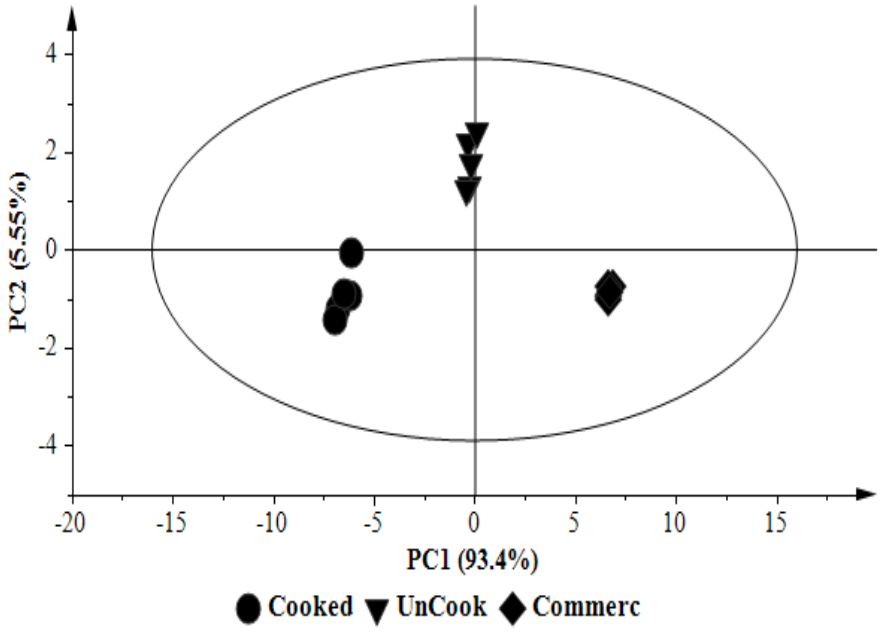

Figure 1. PCA scores plot: the scores plot (PC1 vs PC2) showing sample clustering

To understand more the underlying variables responsible of the clustering observed on scores plot, a loadings scatter plot was computed (Fig 2). The evaluation of the PCA loadings scatter plot permitted to highlight the variables that contribute significantly to the sample clustering (in scores plot), and these include TSS, TDS, moisture, energy and ash content (Fig. 2). However all the three samples do not demonstrate considerable degree of similarities in both PC1 and PC2 components, indicating a significant degree of spurity.

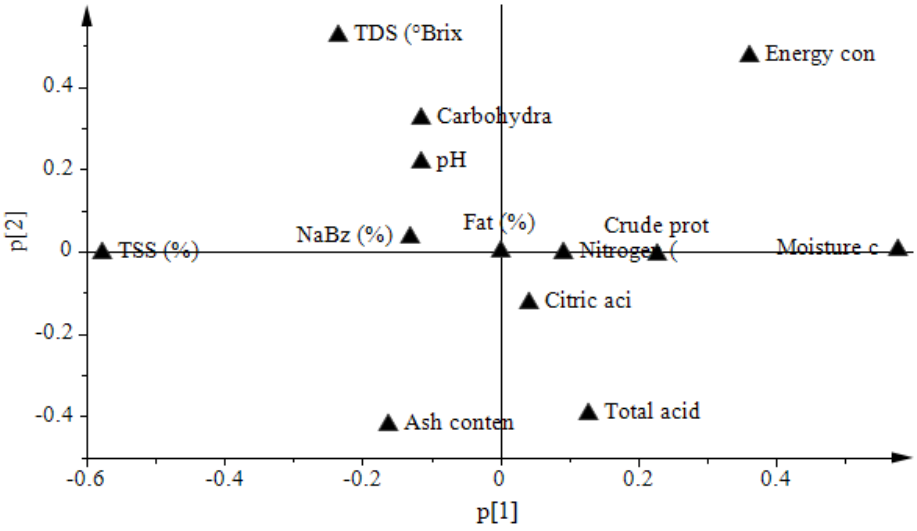

Figure 2. PCA loadings plot showing variables that are responsible for sample clustering

IV. CONCLUSION

This study has revealed a number of observations both for the samples of interest and the commercially available ginger beverage. Although some parameters are comparable, others are not. The absence of the standards against which the comparisons could be made for the juices also makes it difficult to prescribe informed recommendations and drawing of the appropriate conclusions. The results obtained showed that the ginger beverages are nutritious especially the uncooked ginger beverage because of its high protein content. This is in sync with the recommendation that most foods should not be boiled excessively to avoid loss of most nutrients. The non-nutritious values are still acceptable except that of sodium benzoate, but it can be decreased to acceptable limits. The general overview of the results through principal component analysis shows that all the three samples are not considerably different. In conclusion, these beverages stand a good chance to be in the market because few brands of ginger beverages are sold here in Lesotho and the tested samples portray similar properties to the commercially available brand.

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