

Determination and comparison of physico-chemical properties of home-made juices in Lesotho and commercial juice available in the local markets

Abstract

The study was carried out to investigate the comparative nutritional value and physicochemical properties of home-made apple juice and mixed fruit juice (apple, banana and pear) with commercial 100% apple juice. The principal component analysis model revealed the complete difference between these juices with major source of difference being moisture, ash and ascorbic acid contents. Ascorbic acid was found to be lower in home-made juices (1.6 ± 0.01 , 1.78 ± 0.79) as compared to the commercial juice (3.41 ± 0.76 g/100ml), ash content ranged between 1.94 ± 0.06 , 0.19 ± 0.02 and $1.97 \pm 0.76\%$, for home-made apple juice, mixed fruit juice and commercial juice respectively. Moisture content was comparatively higher in commercial juice ($87.8 \pm 0.03\%$) than in home-made apple juice and mixed fruit juice (84.3 ± 0.2 and 84.4 ± 0.07). The nutritional value of home-made apple juice did not differ significantly ($p=0.5$) from that of commercial juice.

Keywords:Physicochemical properties, nutritional value, home-made juices, principal component analysis

1. Introduction

Fruit juice is a natural fluid that can be obtained by crushing or squeezing of fruits [1]. It may also be produced by extracting it with water resulting in water extractable juices. It is commonly used as a beverage or as ingredient in other foods. Juice is widely consumed due to its health benefits which it possesses due to variety of micro-nutrients it contains. These include potassium, magnesium and calcium. Potassium helps the heart to beat by energizing its squeeze of blood, magnesium helps prevent heart attack and stroke and calcium helps in strengthening bones and teeth[2]. In addition, fruit juices have a very low content of fat and sodium which have negative effects when ingested in large amounts.

Fruit juices have all essential physical, chemical, organoleptic and nutritional properties of the fruits they are produced from. And if juice is properly processed, it has all nutritional value and essential properties of the fruits it is produced from[3]. Juices are classified according to total soluble solids present, juice content and kind of processing used [4]. For instance, juice that contains 100% juice and it was not altered from its concentrate; it is called 100% juice. The main constituent of juice is water which accounts for 70 - 97 % juice[5].

33 Water content in fruits is mostly influenced by cultivation and post-harvest conditions. The
34 second largest component is carbohydrates which range between 3-25%. These are mostly
35 sugars, glucose, fructose and sucrose being the most abundant[6]. Carbohydrates are
36 responsible for energy provided by fruit juice. Other components include proteins, acids,
37 phenolics, dietary fibre, pigments, minerals, vitamins and lipids are present in trace amounts.
38 Proteins are high in oily fruits. Different acids present include mainly citric, tartaric, malic,
39 acetic, lactic, and ascorbic. The abundance of vitamins depends on the soil and species of
40 fruits. The amount of dietary fibre is mostly abundant in the peels and the cores [7].

41 The most common ingredients in juices are fruits or reconstituted juice, water, preservatives,
42 sugar, acid and colour. Fruits are used in direct method of juice production whereby juice is
43 mechanically squeezed out of fruits using juicer or juice extractor, while reconstituted juice is
44 used in indirect method. Water is used to dilute the concentrate to a certain value of total
45 soluble solids required for aimed kind of juice. This water has to be clean and portable to
46 minimize contamination by pathogens and other microorganisms. Since fruit juices have very
47 high content of water, they are prone to microbial growth thus they have to be refrigerated.
48 Also preservatives such as sodium benzoate, sulphur dioxide or sorbic acid may be used to
49 increase their shelf-life. These preservatives work effectively at a certain prescribed
50 pH usually below 4.3, therefore amount of acid added has to maintain correct pH. The
51 commonly used acid is citric acid which is expected to range between 0.39 - 1.1% in juices
52 [8].

53 Aim of this project was to investigate comparative nutritional and physico-chemical
54 properties of home-made apple and mixed fruit juices with commercial 100% apple juice
55 obtained from the local supermarket.

56

57 2. Materials and methods

58 2.1 Sample collection and storage

59 Samples of home-made juices - apple juice and mixed fruit juice composed of apples,
60 pears and bananas in the ratio of 3:2:1 were collected from one cooperative that was producing
61 them for sale. The commercial 100% apple juice was purchased from the local supermarket
62 and was used for comparison. These samples were stored in a refrigerator below 5 °C till
63 further use.

Comment [G1]: How much of each! Rev. 1

2.2 Analysis of physico-chemical properties

The pH of the samples was determined using digital pH meter. Total soluble solids content was measured using arefractometer after placing a drop of sample on the prism. Moisture content and ash content were determined by standard AOAC method [9]. Total titratable acidity and citric acid contents were analysed by dissolving the sample in distilled water and titrating with 0.1M sodium hydroxide [10]. The acidity contents of the juices were calculated by the equations:

$$\text{Total acidity} = \frac{\text{weight of acid}}{\text{weight of sample}} \times 100\% \quad : \quad \% \text{ citric acid} = \frac{\text{Titre} \times 0.0064 \times 100}{10 \text{ ml juice}}$$

2.3 Analysis of nutritional properties

The crude proteins content was estimated by Kjeldahl method [9]. This method involves three steps which are; digestion of sample with sulfuric acid, distillation of produced ammonia into trapping solution and titration with standard solution. The equation, crude protein = %nitrogen $\times$ 6.25 was then used to compute amount of crude proteins. Carbohydrates were determined by phenol-sulfuric acid method [11]. And ascorbic acid content was determined by redox titration method with potassium iodate in presence of potassium iodide [12].

Principal component analysis of the total parameters analysed was carried out using Simca-P software to show the variation of these parameters for different juice samples to give the bird's eye view of the variation, and to elucidate the major contributors to the major variations among the juice samples.

3. Results and discussion

3.1 Analysis of physico-chemical properties in the juice samples

Table 1 shows the physico-chemical properties of juices which include pH, total titratable acidity, citric acid content, total soluble solids and moisture content. The pH of home-made juices (2.83 ± 0.02 and 3.04 ± 0.02) was found to be lower than that of commercial juice (3.37 ± 0.03) at $p=0.5$. The low pH of home-made juices is advantageous since it indicates its richness in organic acids compared to the commercial one. Also, all pH values of juices are below pH 4.3 above which the growth of pathogens is rapid.

97 **Table 1** Physico-chemical properties of juices*

Property	Apple juice	Mixed fruit juice	Commercial juice
pH	2.83 ± 0.02	3.04 ± 0.02	3.37 ± 0.03
Total titratable acidity/ %	0.512 ± 0.012	0.578 ± 0.009	0.421 ± 0.014
Citric acid/ %	0.514 ± 0.007	0.580±0.009	0.420±0.015
Total soluble solids/ °brix	4.89 ± 0.02	5.80 ± 0.02	5.59 ± 0.02
Moisture content/ %	84.29 ± 0.18	84.4±0.07	87.8±0.03
Ash content/ %	1.94 ± 0.06	0.19 ± 0.02	1.97 ± 0.03%

98 * Values calculated for n=3 and the confidence interval calculated p = 0.05

99
100
101 Total titratable acidity ($0.512 \pm 0.012\%$, $0.578 \pm 0.009\%$) together with citric acid content
102 ($0.514 \pm 0.007\%$, $0.580 \pm 0.009\%$) of home-made juices is significantly greater than that of
103 commercial juice ($0.421 \pm 0.014\%$ total titratable acidity and $0.420 \pm 0.015\%$ citric acid). Citric
104 acid is a weak organic acid that occurs naturally [13]. Its high content proves what was
105 predicted earlier by low pH values of home-made juices. Apart from this, citric acid enhances
106 flavour and increase shelf-life of beverages. Therefore home-juices are better off in
107 consideration of this factor. The acidity and citric acid content of these juices are almost the
108 same showing that the acidity of juices is due to present citric acid. The acidity increases
109 during **storage** due to fermentation and oxidation of the sugars [14].

110
111 Total soluble solids are influenced mostly by sugars and fruit acids [15]. These are mostly
112 influenced by combined effects of stages of maturity and ripening conditions. They were
113 found to be different in home-made juices (4.89 ± 0.02 , 5.80 ± 0.02) and commercial juice
114 (5.59 ± 0.02). But the difference does not disadvantage any juice; instead it shows their
115 different classification.

116 Beverages are mostly consumed to quench the thirst. Therefore they are expected to have
117 high water content. Moisture content is a measure of amount of water present within a
118 material. It was found to be lower in home-made juices ($84.29 \pm 0.18\%$, $84.4 \pm 0.07\%$) as
119 compared to commercial juice ($87.8 \pm 0.03\%$). Though the moisture content of home-made
120 juices is smaller than that of commercial but its percentage still indicate water content enough
121 to quench the thirst.

3.2 Analysis of nutritional value of the juice samples

From table 2, the analysed nutritional properties of juices are shown together with their corresponding values.

Table 2 Nutritional properties of juices*

Property	Apple juice	Mixed fruit juice	Commercial juice
Vitamin C (mg/100ml)	1.6 ± 0.01	1.78 ± 0.79	3.41 ± 0.76
Carbohydrates (mg/100ml)	2.40 ± 0.05	4.17 ± 0.74	2.63 ± 0.37
Crude proteins (mg/100g)	1.197 ± 0.052	1.722 ± 0.438	1.05 ± 0.12
Fats (mg/100g)	Not detectable	Not detectable	Not detectable

* Values calculated for n=3 and the confidence interval calculated p = 0.05

Ascorbic acid is water soluble compound that is essential for life. It is important for fruit juices to contain it since the body cannot produce it by itself. And it was therefore found to be present in home-made juices (1.6 ± 0.01 - 1.78 ± 0.79 mg/100ml) though it is in lower quantities compared to the commercial juice (3.41 ± 0.76 mg/100ml). Their difference is significant at p = 0.5. The higher concentration of vitamin C in commercial juice is due to its addition during the production. But that does not make the home-made juices less healthy because ascorbic acid, even in less concentration can still protect the indispensable molecules of the body against damage by free radicals [16].

Carbohydrates and proteins are important nutritional parameters. Carbohydrates provide energy and proteins function as building block for many parts of the body. Juices are known to be poor sources of proteins. Thus they were found as 1.19 ± 0.05 , 1.72 ± 0.44 and 1.05 ± 0.12 g/100g for home-made apple juice, mixed fruit juice and commercial juice respectively. From the results, home-made apple juice and commercial juice protein content does not differ significantly and they are both lower than that of home-made mixed fruit juice. This is because they are both made from apples and hence juices are expected to have same nutritional value as their fruits. And thus mixed fruit will have more since bananas are rich in proteins. The same reasoning applies to carbohydrates content of these juices which were found as 2.40 ± 0.05 g/100ml, 4.17 ± 0.74 g/100ml and 2.63 ± 0.37 g/100ml for home-made apple juice, mixed fruit juice and commercial juice respectively.

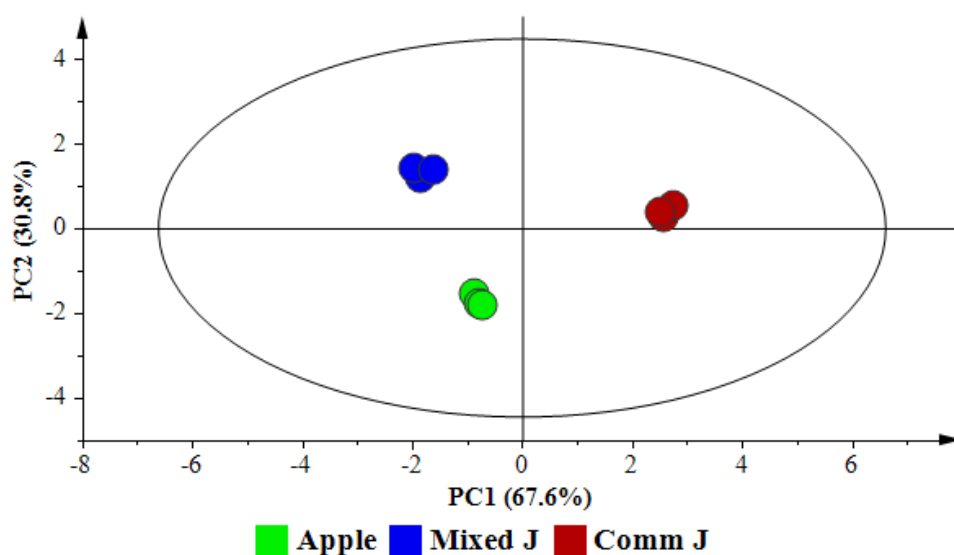
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149 The absence of detectable levels of fats is a good attribute since juices are not expected to
150 contain any fats.

151

152 3.3 Comparison of the juices using principal component analysis

153 The general comparison of these juices using PCA yielded the results demonstrated in
154 Figures 1 and 2. Figure 1 demonstrates the scores plot of the three juice samples.



155

156 **Figure 1**PCA scores plot - the scores plot (PC1 vs PC2) showing sample clustering of the
157 three samples

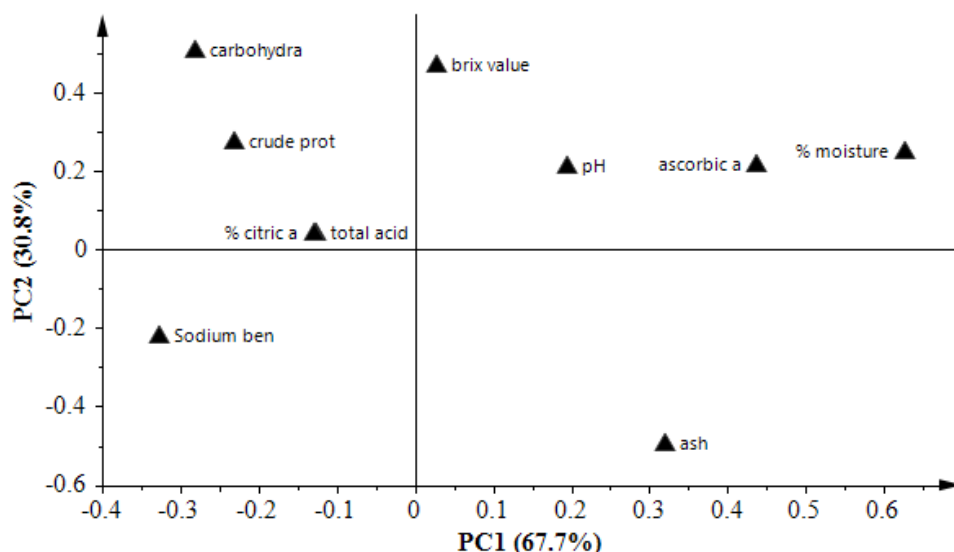
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159 From Figure 1, it can be seen that all the juices are different as they are not clustered together.
160 These juices do not differ significantly since the largest variation in PC1 accounts for only
161 about 68% of the variation, while the variation in the PC2 is also about 30%. This means that
162 the data does not show good clustering, possibly due to limited data used in this analysis if
163 not the lack of significant differences thereof.

164 The loading plot (see Figure 2), shows that the variables responsible for this difference are
165 moisture, ascorbic acid and ash content in the PC1. Generally, what brings big difference in
166 home-made juices and commercial juice is processing methods used. Moisture content is low

167 in home-made juices because the juice is prepared by cooking the whole pulpy fruit, and it
 168 still remains cloudy even after filtering. This implies presence of more solids in it. However,
 169 by way of the actual content, there is not major difference between the moisture content of
 170 these juices as can be seen from Table 1. Regarding the ascorbic acid, the second component
 171 posing some difference, the difference is brought about its exogenous addition during
 172 production of commercial juice. Ash content is a measure of total minerals present within
 173 food. It was found to be extremely low in mixed fruit juice ($0.19 \pm 0.02\%$) as compared to
 174 commercial juice ($1.97 \pm 0.03\%$) whose content do not differ significantly (at $p = 0.5$) from
 175 that of apple juice ($1.94 \pm 0.06\%$). The low content of ash in mixed fruit juice may be due to
 176 less quality of fruits used in its production or low juice content.

177



178

179 **Figure 2** PCA loadings plot - the scores plot (PC1 vs PC2) showing variables that are
 180 responsible for sample clustering seen on scores plot

181

182 Since the correlation between other properties and PC2 is not that strong as compared to
 183 mentioned three properties, this means that they do not contribute much to the overall
 184 difference of home-made juices and the commercial juice.

185 **4. Conclusion**

186 All physico-chemical properties of home-made juices were found to differ from that of
187 commercial juice. But the differences do not disadvantage the home-made juices.
188 Some differences (such as total soluble solids) simply reveal difference in classification of
189 these juices. The nutritional value of home-made apple juice and of commercial juice was not
190 significantly different at $p=0.5$. This was expected since juice is to have all nutritional value
191 from their fruits and thus both of these juices are from apples. In overall comparison, home-
192 made juices are different from commercial juice. The properties of these juices that bring
193 major difference are ascorbic acid, moisture and ash contents.

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