

Physicochemical properties and sensory attributes of homemade bakery products from two local varieties of pineapple compare with the locally available market products in Bangladesh

Abstract

Pineapples (*Ananas comosus* L. Merr) contain beneficial properties and the object of the study is to compare the physical and chemical properties of two local varieties of pineapples and their prepared bakery products such as jelly and biscuit using flesh of pineapple as one of the raw materials and compare those with the locally available market products. Physico – chemical properties such as fruit weight, diameter, length, edible portion %, pH, Vitamin C, Titratable acidity, sugar content, total soluble solids, lipid content , crude protein, phenolic compound and sensory attributes (Firmness, sweetness, tartness, colour, and overall acceptability) of fresh pineapple fruit of Honey Queen (HQ) and Giant Kew (GK) were studied. Both the varieties contained high amount of moisture, GK 84.42% and HQ 83.95%. Further, HQ variety showed more than GK variety in almost all of the properties. The phenolic contents of the extracts as caffeic acid equivalents were found to be highest in methanol HQ (12.45%), GK (9.8%) while in water extract HQ (5.4%), and GK (5.3%). In terms of prepared bakery product from pineapple, Sample H (Home prepared) was more preferable than the locally market available brand in consideration of the physico-chemical properties that affected the sensory attributes acceptability having the overall acceptability score of 7 in a 9-point hedonic scale.

Keywords: Pineapple, Physico-chemical analysis, Market product, Home-made bakery products, Sensory attributes,

1. Introduction

In Bromeliaceae Family, Pineapple [*Ananans comosus* (L.)Merr.] is a wonderful tropical plant with edible multiple and named after its similarity to the pine cone. Moreover, this perennial monocotyledonous plant with a terminal multiple fruit having exceptional juiciness, vibrant tropical flavour and immense health benefits. Pineapple is one of the most important commercial fruit in the world. Pineapple is known as the queen of fruits for its excellent flavour and taste [1]. Mature fruit is rich of sugar; a protein digesting enzyme bromelin, and also good amount of citric acid, malic acid, vitamin A and B [2]. The tropical climate is better for pineapple cultivation.

Generally, it is grown almost all over Bangladesh especially in hilly and high land where there is no water stagnation. In Bangladesh Pineapple is cultivated in the districts of Tangail, Mymensingh, Gazipur, Sylhet, Moulvibazar, Chittagong, Bandarban, Khagrachari and Rangamati [3]. There are ninety varieties of pineapple have been cultivated in the world but three varieties: Giant Kew (GK), Honey Queen (HQ) and Ghurasal are mostly grown in Bangladesh. Although GK has intensively been cultivated in Tangail but the climate and the soils of Chittagong are suitable for the production of GK and farmers are cultivated this variety in Chittagong hilly zone. On the other hand HQ is largely produced in Chittagong hilly zone [3]. Fresh pineapple is often expensive because of its delicate nature and its short and limited shelf life [4]. Because of its sweet and sour taste, it is delicious to be consumed fresh fruit or processed food. Development of a pineapple powder from pineapple pulp as a value-added ingredient for the bakery and confectionary industries is an alternate solution [5]. Pineapple as a rich source of vitamins A, B and C besides several minerals such as calcium, phosphorus, iron and antioxidant activities is consumed in many parts of the world as fresh fruit, juice, jam, jelly and dried product [6]. In the developing countries processed food consumption will continue to increase without policy intervention [7, 8, and 9]. Processed foods are significant sugar, salt and fat vectors in the nutrition transition underway in the developing countries of Asia [10].

Thus, the objective of this study is – i) to compare physicochemical properties of the varieties, ii) to analyze the biochemical characteristics of the cultivars and iii) to evaluate the sensory attributes of homemade bakery products using pineapple flesh as one of the food ingredients and also compare it with the locally available market products in Bangladesh.

2. Materials and Methods

2.1. Sample Collection and Taxonomy:

Two local cultivars, Honey Queen (HQ) and Giant Kew(GK), (Figure 1.); were collected from local market of Chittagong, Bangladesh Hill tract mainly Kaptai and Bandarban which lies in southeastern part of the Country ($21^{\circ} 25' N$ to $23^{\circ} 5' N$ latitude and $91^{\circ} 54' E$ to $92^{\circ} 50' E$ longitude). Classified and identified by the Department of Botany, Chittagong University, Chittagong 4331, and Bangladesh).

2.2. Preparation of Juice sample:

Pineapples were weighed using a top loading balance. The length diameter and edible portion of samples were measured and juice extraction from the samples were performed according to the method as described by Lim. (1985) [11]. The fruits were washed, manually peeled, cut into halves with sterile knife using hand gloves then cut pineapple were pressed with a hand juicer to extract the juice. The Juice and pulp obtained were blended in a sterile blender. The homogenate was clarified manually using a sterile muslin cloth to obtain a clear juice.

2.3. Determination of Moisture

Moisture of pineapple was determined following the Conventional method [12].

2.4. Determination of Vitamin C

5ml of pineapple juice sample was pipetted out in a 100 ml conical flask. 10ml of 4% oxalic acid was added and titrated with the DCPIP $5 \times 10^{-4} \text{ mol}\cdot\text{L}^{-1}$ solution until a pink tint appears that persists for about 30 seconds. [13]

2.5. Determination of Water-soluble protein, TSS, Total Sugar and lipid content

The method of Folin Lowry [14] was used for the determination of water-soluble protein. Total sugar content was determined following the Anthrone method [15]. Lipid content was detected by the method of Bligh and Dyer (1959) [16]. The pineapple sample is homogenized with a mixture of chloroform and methanol in such proportions that a miscible systems formed with the water in the sample. Dilution with chloroform and water separates the homogenate into two layers. The chloroform layer was dried to obtain lipid.

2.6. Determination of Total Soluble Solids (TSS)

TSS was determined by Refractometer [17] as degree brix ($^{\circ}\text{B}$). At first 2 g of fresh pineapple was taken into a mortar and smashed well. Then a drop of juice was squeezed on the prism of the Abbe Refractometer and the percent of TSS obtained from the direct reading of the instrument was recorded.

2.7. Determination of pH

pH value of the fruit extract was done with a PYE Unicam Model MK2 pH Meter. The pH meter was standardized by use of standard buffers solution of pH 4 and pH 9, before measuring the pH of the juice.

2.8. Determination of Total Titratable Acidity (TTA)

Sample of pineapple juice (10 mL) was weighed and transferred to a 500 mL Erlenmeyer flask. The sample was diluted to 250 mL with deionised water. Using a standard solution of 0.1 N sodium hydroxide (Hanns, Analytical grade), the sample was titrated to the end point and that end point was determined by pH meter using phenolphthalein as indicator. The volume of 0.1 N sodium hydroxide used was recorded. The total acidity is calculated using the following equation by CBPL METHOD 20-08 and expressed as concentration of citric acid (g/L). The measurement was repeated at least three times.[18]

$$\% \text{ Acid (as anhydrous citric acid)} = \text{Volume of 0.1 N NaOH (in mL)} \times 0.64 / 10.$$

2.9. Determination of total phenol

As stated by Folin – Ciocalteu method, total phenol content was measured using spectrophotometer and external calibration with caffeic acid [19]. Pineapple extract solution (0.2 mL) and 0.2 mL of Folin–Ciocalteu reagent were added and the contents mixed thoroughly. After 4 minutes, 1 mL of 15% Na₂CO₃ was added and then the mixture was allowed to stand for 2 hrs at room temperature. The absorbance was measured at 760 nm using spectrophotometer. The concentration of the total phenolic compounds was determined as mg of caffeic acid equivalent by using an equation obtained from caffeic acid calibration curve. The estimation of phenolic compounds in the fractions was carried out in triplicate and the results were averaged.

2.11. Sensory evaluation of Biscuit and Jelly incorporated with pineapple juice

Sensory evaluation of the biscuit and jelly were conducted as reported by Meilgaard *et al.* (1999)[20] using 10-members panel randomly selected from the university community. Samples of jelly and biscuit were presented to each of the panelist and were asked to assess the colour,

flavour, sweetness, taste and overall acceptability using nine-point hedonic scale. The scale was arranged such that: 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely. The analysis was performed for the freshly made and market process jelly and biscuits. All sensory evaluations were performed under the same protocol which was approved by the Ethic Committee Faculty of Basic Medical and Pharmaceutical Sciences, USTC, Chittagong, Bangladesh. It may mention that all the raw materials used for preparation of food products are good for health.

2.12. Statistical analysis

Data were calculated and analyzed using the excel and normal statistical tools. The results were evaluated by Analysis of Variance (ANOVA) and Fisher's LSD Multiple Comparison Test.

3. Result and Discussion

Generally fruit will the following stages during its growing periods – such as development, premature, mature, ripe and senescent, and the maturity of the fruits can understand by observing the changes of color. Further, measurement of color values would give an indication of the extent of browning or darkening of the product. Proximate composition of nutrients and physico-chemical properties of fruits play a vital role in proper development and good health of human body. As the pineapple maturity stages increased, all the texture parameters, such as hardness, springiness, cohesiveness, gumminess, and chewiness, decreased significantly. [21].

3.1. Evaluation of Physical Properties

The physical properties of experimental types of pineapple cultivars are presented in the Table 1.

The results clearly indicated that in relation to fruit dimensions (Weight, Diameter and Length), GK had significantly higher values than HQ in all those parameters and the edible portions of the varieties were ranged from 64 to 66.75% [22]. In term of sensory acceptability Table.2, HQ showed good color, yellow upon ripen however the GK showed more greenery appearance upon ripen and HQ was also more superior to GK in all attributes. So, the sensory attributes such as color, firmness, sweetness and tartness strongly affected the overall acceptability of the

pineapples. These properties determine the quality of the fruit, and identification of correlations between changes in these properties makes quality control easier [23].

3.2. Chemical characteristics

The data for different chemical composition of GK and HQ are presented in Table 2. Moisture content is an important parameter in assessing the quality of fresh fruits as high moisture content is an indicative of less shelf life and hence suitable preservation methods must be applied for its better utilization. The values of moisture content of both the cultivars was found to be very similar and varied between 83 – 85% that are very close to the reported values [24].

The content of lipid in two varieties HQ and GK were found to be varied 0.75% to 0.85%, that is slightly higher than the reported values [24] and also suggested that pineapples are not good sources of fat [24]. Between the two cultivars, GK had the less soluble protein (0.74%) as compared to the HQ (0.87%) as shown in Table 2 that is moderately higher than the reported values [24]. From this study it is clear that HQ had the more sugar content than GK and it was 3.73% for GK and 5.57% for HQ [25]. The content of sugar plays an important role in the preference of the consumer selection. Total dissolved solids (TSS) are an important parameter of fruit quality that states the amounts of soluble solids in liquid. TSS value affects the taste of the fruit, because it can indicate the level of sweetness of the fruit. The amount of TSS present in the juice of GK and HQ were found to be 13% and 17%, respectively as shown in Table 2, which is within the range as reported by Wardy *et al.* [26]. TSS varies from 10% to 14% °brix depending upon the stage of maturity and season [27]. Ascorbic acid value of pineapple is largely variable depending on factors such as the cultivar, stage of maturity, conditions of storage and the part of fruit and it ranges from 20 mg /100 mL to 34.44 mg/100 gm as reported [28 and 29]. According to May and Qu, [30] vitamin C plays an antioxidant role and possesses several health benefits. In this study, the content of Vitamin C of two local varieties was measured by DCPIP method and both the local cultivars showed about 23mg per 100 mg of pulp that are supported by the reported values also [31]. It was reported that the decline in titratable acidity upon ripening was due to the utilization of acid during respiration as a respiratory substrate and for the generation of ATP [32 and 33]. Titratable acidity (also called total acidity) measures the total acid concentration in a food. It is also a better predictor of acid's impact on flavor than pH [34]. The

decline in acidity could be due to susceptibility of citric acid to oxidative destruction as impacted by the ripening environment. It was reported that the decline in titratable acidity upon ripening was due to the utilization of acid during respiration as a respiratory substrate and for the generation of ATP [35]. In this result, GK and HQ appear to have little effect on titratable acidity and it was found to be varied between 0.86–1.1 2%. The pH of the two varieties were HQ (4.36 ± 0.06) and GK (4.35 ± 0.03). The average values of total titratable acidity as (% of citric acid) in the persimmon pulp was 0.14% and that in the jelly, 60:401 and 60:302 were 0.78% & 0.84%, respectively. Jam product with a low pH and a high %TTA is considered adequate on health ground and for storage purposes [36].

3.3 Phenolic content of Pineapple extract

The phenolic contents of the fruit extracts of pineapple were tested through Folin–Ciocalteu method and reported as caffeic acid equivalents. As shown in Figure 2, all the used solvents were capable of extracting phenolic compounds. However, Ethyl extract was found to be more effective solvent as compared to water for extracting total phenolic compounds from pineapple. HQ contained considerably more phenolic compounds (12.45%) than GQ (9.8%) in ethyl extracts but water extracts yield almost the same amount for both the varieties which was about 5.4% [37].

3.3. Sensory evaluation of Jelly and Biscuits incorporated with pineapple juice

Biscuits Preparation:

Sweet biscuits were prepared using the traditional creamy method. Refined flour (250 gm), sugar powder (50 g), vegetable oil (36 g), skim milk powder (6 g), salt (1 g) and baking powder (2gm) - a product of MUSKAN Brand Bangladesh were used as recipe for preparing biscuits. First of all, pineapple pulp of HQ variety had to grind. Sugar and 25ml pineapple (HQ) pulp juice were mixed along with skim milk powder. Then flour and baking powder was added with salt. The contents were mixed further for around 4 minutes to make the dough. Using a wooden roller, the dough was sheeted on specially fabricated wooden platform to a uniform thickness of approximately 2.5 mm. Circular shape biscuits were cut and baked for 15 mins at 220°C in a baking oven. The Biscuits prepared this way were packed and compared with the commercially available pineapple biscuits collected from the market.

Production and Sensory Properties of Pineapple Jelly:

The Juice of HQ (300ml), Sugar (250 g) and lime juice (10ml) were used to prepare sugar syrup. The syrup was boiled at 100°C and allowed to boil again until a slippery feel to gel was formed. The mixture was left at room temperature for 20 minutes and subsequently cooked slowly with infrequent stirring for 15 minutes. The jelly was poured into a sterilized bottle and allowed to cool at a room temperature (29°C -32°C) for further analysis. Finally sealed, labeled and stored in a cool dry place. The quality of the prepared jelly was then compared with the market available jelly.

The sensory scores of the prepared pineapple product jelly and biscuit were shown in Figure 3. The jelly and biscuit samples both Homemade (Sample H) and from the local Market (Sample M) varied significantly ($p < .05$) in terms of color, flavor, sweetness, taste and overall acceptability. Taste is an important attribute in acceptance of food product. The average score by the taste panelists showed a strong sweetness (7.4), taste (8.1) and overall acceptability (7.8) in Sample H, jelly and a nearly strong sweetness (7.2), fair taste (6.9) and overall acceptability (7.2) in Sample M jelly. They also found out strong flavor (8.2) and color (7.5) in Sample M but nearly fair flavor (7.2) and color (6.9) in Sample H, which might be due to use of artificial flavor and color during preparation of local products. On the other hand, no artificial substances were used in the preparation of home made products. Between the biscuit samples, biscuit sample H had the highest mean score for taste (7.8) and overall acceptability (7.0), while the Sample M had the least mean score (taste-6.9, overall acceptability- 6.5). Biscuit Sample H was least preferred in terms of color (7.2), flavor (6.9) and sweetness (7.6) while the Sample M was the most preferred in terms of color (8.2), flavor (7.4) and sweetness (7.8).

3.4. Comparison of Physiochemical properties of Sample H pineapple Jelly, Biscuits and Sample

The TSS is primarily represented by sugars, with acids and minerals contributing. For assessing the strength of gel and texture, TSS and pH play an important role [38]. In this study pineapple food product Jelly and Biscuit for Sample H showed higher rate of TSS than Sample M and it were 75.3, 67.3, 55.4, 47.3 (Figure 4), pH value was almost same in all the products and it was acidic in nature. In the Sample H biscuits and Jelly showed higher lipid content than the Sample M. The moisture content in jelly of Sample H and Sample M was 35.64 and 31.19% and in

biscuit 8.74 and 7%, respectively suggesting as the upper limit needed for the biscuits to prevent spoilage by microorganisms and to increase the shelf-life [39]. According to Brooker *et al.* [40], reduction in fat content was due to the oxidation of unsaturated fatty acids with the atmospheric oxygen and moisture uptake during storage. In the present result, lipid content of jelly in Sample H 1.9% and Sample M were 1.9% and 0.7%, in contrast moisture content 35.64% and 31.19%, respectively. According to Bertagnolli *et al.*, 2014 [41] biscuits with low moisture content will have longer shelf life if they are stored under control conditions and in this result moisture content of biscuit sample H and sample M were calculated to be 8.74% and 7.0% while lipid content was 13.65% and 9.76%, respectively the lowest rate of decreasing trend in fat content may be due to low initial moisture content in the biscuits [42].

4. Conclusion

Although Bangladesh is one of the high pineapple producing countries of the world and ranks 4th in terms of total cropping area and production but yet food industry in our country did not use pineapple pulp largely as raw materials. Bangladesh produces 200701 metric tonnes of pineapple from 13556 hectares of land during 2015-16 cropping season. The production of fruits including pineapple is increasing day by day in Bangladesh [43].

This study might be encouraged the producer to select pineapple pulp powder as raw materials both in the Food and Bakery industry. Furthermore, this result suggests more investigation in the future to optimize the formulations. Again, this study provides the information of consumer preferences about the expectation of these types of bakery products.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Acknowledgement

The authors wish to thanks **Md Rezaul Hoque Srejon** making the research possible but it was unfortunate that he was died because of COVID 19. Special thanks to USTC authority for providing necessary facilities for conducting the study.

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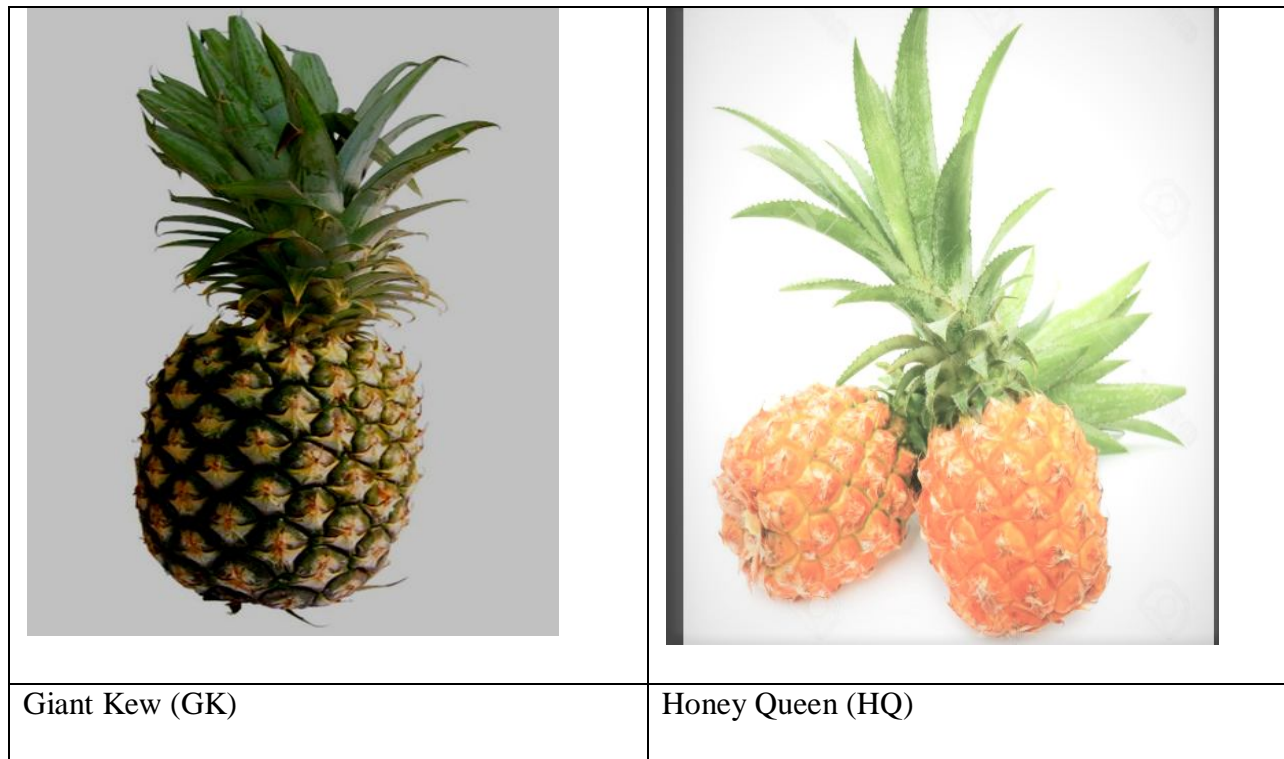


Figure 1. Two varieties of pineapple GK and HQ

Table 1. Physical properties of two pineapple varieties

Physical Properties	GK	HQ
Fruit weight (kg)	1.1±0.15	0.60±0.12
Diameter (cm)	17±2.3	10±2.12

Length (cm)	24±2.7	15±2.88
Edible portion (%)	64±2.73	66.75±1.58

* The values are means ±SD of three replicates

Table 2. Sensory attributes of two pineapple varieties

Sensory attributes	GK	HQ
Colour	Light yellow	yellow
Firmness	Fair	Good
Sweetness	Fair	Very good
Tartness	Strong	Fair
Overall acceptance	Moderate	Strong

Table 3. Chemical properties of two pineapple varieties

Chemical properties	GK	HQ
Moisture (%)	84.42±0.05	83.95±0.02
Lipid (%)	0.85±0.03	0.75±0.01
Protein (g %)	0.74±0.05	0.87±0.09
Total sugar (g %)	3.73±0.02	5.57±0.01
TSS (%)	13.1±0.57	16.93±0.28
Vitamin C (mg/100 mL)	22.59±0.02	22.56 ±0.12
Titrateable acidity (%)	1.12 ±0.25	0.86±0.18
pH	4.35±0.03	4.36±0.06

* The values are means ±SD of three replicates

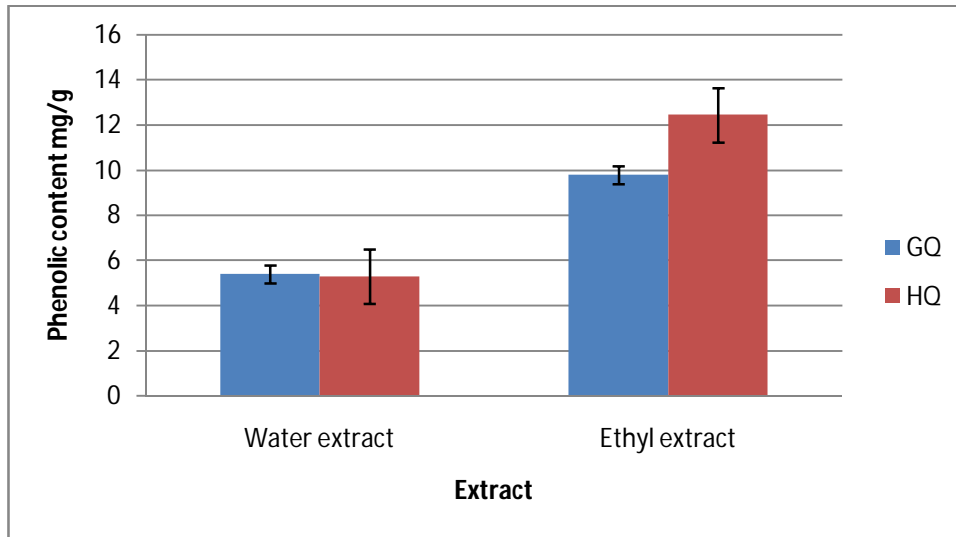


Figure 2. Phenolic contents (as caffeic acid equivalent) of pineapple extracts. The values are means \pm SD of three replicates.

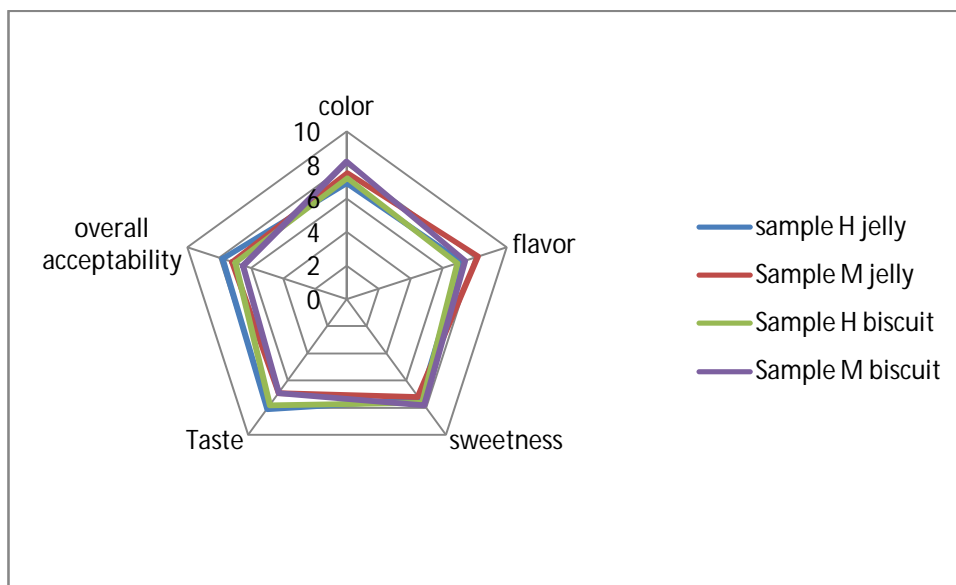


Figure 3. Sensory evolution result of pineapple jelly and biscuit (Homemade- Sample H, Market- Sample M). The values are means \pm SD of three replicates.

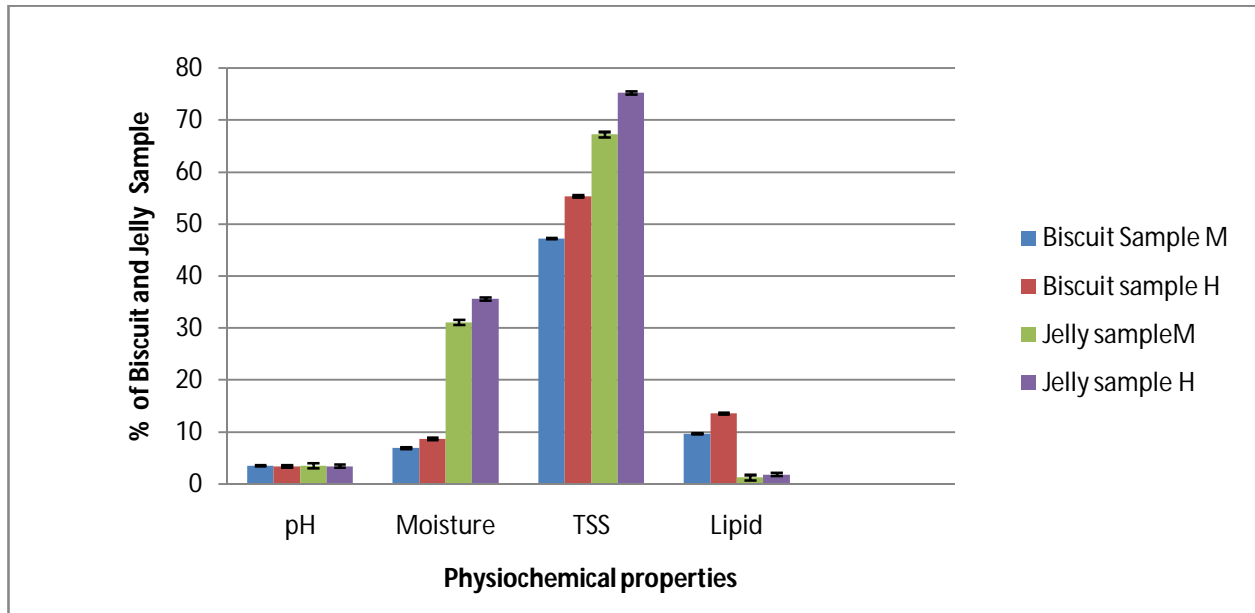


Figure 4. Physiochemical properties of Sample H pineapple Jelly and biscuits in compared with Sample M. The values are means \pm SD of three replicates.