Original Research Article

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

Abstract

This study was carried out to determine the physicochemical and sensory properties of blends of mature pineapple. 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. Several physico-chemical properties (Fruit weight, diameter, length, % of edible portion, pH, Vitamin C, Titratable acidity, Total sugar content, Total soluble solids, Lipid content , Crude protein, Phenolic compound and sensory attributes (Firmness, sweetness, tartness, colour, and acceptability) of fresh pineapple fruit of HQ and GK were studied. Both the varieties contained high amount of moisture, GK 84.42% and HQ 83.95%. HQ variety showed more than GK variety in almost all the properties. Moreover, HQ had considerably more phenols content than GQ. 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 all the physico-chemical properties and it affected the sensory attributes acceptability having the overall acceptability score of 7 in a 9-point hedonic scale.

Keywords: Pineapple, Physico-chemical analysis, Phenolic compounds, Bakery products, Sensory attributes,

1. Introduction

In Bromeliaceae Family, Pineapple [Ananans comosus (L.) Merr.] is a wonderful tropical fruit, in the world. 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 crops in the world. Pineapple 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]. According to Deliza et al. (2005) [5], development of a pineapple powder from pineapple pulp as a value-added ingredient for the bakery and confectionary industries is an alternate solution. 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] .Thus, the objective of this study is to compare the physical and chemical properties of two local varieties of pineapple and their prepared bakery products such as jelly and biscuit using flesh as one of the food ingredients to improve nutritional quality.

2. **Materials and Methods**

2.1. Sample Collection and Taxonomy

Two local varieties, HQ and 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 (21º 25 ´N to 234º5 ´N latitude and 91 º54 ´E to 92º 50 ´E longitude).

2.2. Preparation of Juice sample

Fruits were weighed using a top loading balance. The length diameter and edible portion of samples were measured and juice extraction from samples were performed according to the method as described by Lim. (1985) [7] .

2.3. Determination of Moisture

Conventional method [8] was used for moisture determination from pineapple and two grams of edible part of pineapple was weighed in a porcelain crucible and heated in an electrical oven for about six hrs at 100^0 C. After that it was cooled and weighed again. Percent of moisture content is

(g/100 g sample) = Wt of Moisture x 100/Wt of Sample taken.

2.4. Determination of Vitamin C

Vitamin C content of pineapple was determined by the Dichlorophenol indophenol (DCPIP) method [9]. At first prepared the standard ascorbic acid solution, DCPIP solution and then standardization of DCPIP solution was done. 10 mL of the pineapple juice was taken into a 250 mL conical flask, which contained 25 mL of 0.5% oxalic acid, and 10 mL of distilled water was added. The fruit juice solution was titrated with the DCPIP solution using burette to a pink end point. The test was triplicate and average of the results was being taken. The vitamin C concentration in the fruit juice was calculated by using the following formula:

$$\text{Mole (Vitamin C)} = \text{CV (DCPIP solution)}$$

$$\frac{\text{Mass}}{\text{Molar mass}} = \text{CV}$$

$$\text{Mass} = \text{Mr (Vitamin C)} \times \text{C (DCPIP)} \times \text{V (DCPIP)}$$

* Mr refer to molar mass
* C refer to concentration
* V refer to volume

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

The method of Folin Lowry [10] was used for the determination of water-soluble protein and the reading was taken directly as % TSS by a hand Refractometer. Total sugar content was determined following the Anthrone method [11]. Lipid content was extracted by the method of

Bligh and Dyer (1959) [12] and the procedure was carried out in approximately 10 minutes. 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 containing all the lipids. Then purified lipid extracts is obtained by isolating the chloroform layer.

2.6. Determination of Total Soluble Solids (TSS)

TSS was determined by Refractometer [13] as degree brix (°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 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. **[14]**

% Acid (as anhydrous citric acid) = Volume of 0.1 N NaOH (in mL) × 0.64 / 10.

2.9. Extraction

Pineapples were cut into pieces and washed with deionised water homogenised in a grinder for 3 min to 40-mesh size paste. Twenty five grams of paste samples was extracted with 150 mL of ethyl acetate by mixing, using a magnetic stirrer at 30 °C for 2 h. After that the extract was filtered through Whatman No. 41 filter paper to obtain particle free extract. It was re-extracted

twice and filtered. The extracts were pooled and concentrated and dried under vacuum. Procedure was followed for the other solvents such as methanol and water for antioxidant fractions [15] and the extracts were used to explore their antioxidant activity.

2.10. Determination of total phenol

As stated by Folin–Ciocalteu method, total phenol content was measured spectophotometrically and external calibration with caffeic acid [16]. Pineapple extract solution (0.2 mL) and 0.2 mL of Folin–Ciocalteu reagent were added and the contents mixed thoroughly. After 4 mins, 1 mL of 15% Na_2CO_3 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 phenolics 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. Biscuits preparation

Sweet biscuits were prepared using the traditional creamy method. Refine flour (250 gm), sugar powder (50 g), vegetable oil (36 g), skim milk powder (6 g), salt (1 g) and baking powder (2gm) 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 mins 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 220^0C in a baking oven. The Biscuits prepared this way were packed and compared with the commercially available pineapple biscuits collected from the market.

2.12. Production of pineapple Jelly

The Juice of HQ (300ml) , Sugar (250 g) lime juice (10ml) were used to prepare sugar syrup. The syrup was boiled at 100^0C and allowed to boil again until a slippery feel to gel was formed .The mixture was left at room temperature for 20minutes 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 (29^0 C-32^0 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.

2.13. Sensory evaluation of pineapple products: Biscuit and Jelly

Sensory evaluation of the biscuit and jelly were conducted as described by Meilgaard et al. (1999) [17]. 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.

2.14.. 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**

3.1. Evaluation of Physical Properties

Data presented in Table 1. indicated that in relation to fruit dimensions (Weight, Diameter and Length), GK had significantly higher above values than HQ, while HQ showed good colour, yellow upon ripen however the GK showed more greenery appearance upon ripen. The edible portions of the varieties were ranged from 64 to 66.75% and it was followed to the result of Ahmed and Rahman. (1974) [18]. According to Ali et al. (2015) [19] The edible portion of the fruits increased with days after storage . In sensory attributes, such as colour, 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. In term of sensory acceptability HQ was more superior to GK [19].

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. 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 GK (84.42%) and HQ (83.95%) were observed and the values are found to be within the ranges as described by Adnan et al. (2018) [20].

The content of lipid in two varieties HQ and GK were found to be varied 0.75% to 0.85% indicating that pineapples are not good sources of fat [21] .

Between the two cultivars, GK had the less protein (0.74%) compared to the HQ which had 0.87% protein as shown in Table 2 which following the result of Kader et al. (2010) [21]. From this study it is found that HQ had the more sugar content than GK and it was 3.73% for GK and 5.57% for HQ (Kader et al., 2010) [21].The content of sugar plays an important role in the preference of the consumer selection. Total soluble solids (TSS) of a given sample of fruit juice representing various chemical substances present in it in soluble form. The amount of TSS present in the juice of GK was 13% while the HQ had 4% more TSS than GK as shown in Table 2. and it is similar to the result of Wardy et al. (2009) [22]. TSS varies from 10% to 14% ^{o}brix depending upon the stage of maturity and season [23]. 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 mL [24], [25]. According to May and Qu.(2005) [26] 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. Both the local varieties GK and HQ showed 22.5 mg / 100 mL of Vitamin C and present findings are supported the result of Rasid and Hosain. (1987) [27]. According to Fernando and De Silva. (2000) [28]; Lee and Lee. (2000) [29], 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 (adenosine triphosphate) .In this result GK and HQ appear to have little effect on titratable acidity and it was GK 1.12% , HQ 0.86% followed the research of Wardy et al., (2009) [30]. The pH of the two varieties were HQ (4.36 ± 0.06) and GK (4.35 ± 0.03) .

The phenolic contents of the fruit extracts of pineapple were tested through Folin–Ciocalteu method and reported as caffeic acid equivalents, the results are presented in the (Figure 2). As

shown all the used solvents were capable of extracting phenolic compounds. However, Ethyl extract was found to be a more effective solvent as compared to water for extracting total phenolic compounds from pineapple and it was followed to the findings of Hossain and Rahman (2011) [31]. HQ contained considerably more phenolic compounds than GQ in ethyl extracts and it was 12.45% and 9.8% while water extracts yield almost the same for both the varieties and it was 5.4% for GK and 5.3% for HQ.

3.3. Sensory evaluation of pineapple products (Jelly and Biscuits)

The sensory scores of the pineapple product jelly and biscuit is shown in Figure 2.The jelly and biscuit samples both Homemade (Sample H) and from Market (Sample M) varied significantly ($p < .05$) in terms of colour, flavour, 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 flavour (8.2) and colour (7.5) in Sample M and nearly fair flavour (7.2) and colour (6.9) in Sample H, which might be due to use of artificial flavour and colour during preparation of those 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 colour (7.2), flavour (6.9) and sweetness (7.6) while the Sample M was the most preferred in terms of colour (8.2) , flavour (7.4) and sweetness(7.8).

3.4. Physiochemical properties of Sample H pineapple Jelly and biscuits in compared with Sample M

The TSS is primarily represented by sugars, with acids and minerals contributing. For determine the strength of gel and texture, TSS and pH play an important role [32]. 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±.2, 67.3±.4, 55.4±.2, 47.3±0.2 (Figure 3.). pH value was as same in all product 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 was Sample H and Sample M was 35.64 and 31.19% and in biscuit 8.74 and 7% is suggested as the upper limit needed for the biscuits to prevent

spoilage by microorganisms and to increase the shelf-life [33]. According to Brooker et al. (1992) [34]Reduction in fat content was due to the oxidation of unsaturated fatty acids with the atmospheric oxygen and moisture uptake during storage. In this result lipid content of jelly was Sample H 1.9% and Sample M 0.7% in contrast moisture content 35.64% and 31.19%.According Bertagnolli et al., 2014 [34] 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 8.74% and sample M 7%, respectively and lipid content was 13.65% and 9.76% ,lowest rate of decreasing trend in fat may be due to low initial moisture content in the biscuits [36].

4. **Conclusion**

From this study it might be concluded that Honey Queen is the better variety than Giant Kew and two varieties represent the sources of bioactive compounds, high moisture content and other chemical properties. Moreover the present results suggest that homemade jelly and biscuit from pineapple fruit is better than commercial food product based on the physico-chemical properties and sensory quality which play an important role in people daily diet. Homemade jelly prepares without artificial substance can fulfill the consumer satisfaction and was safe and suitable for consumption up to six month storage in ambient condition. Furthermore, this study provides the information of consumer preferences about the expectation of these types of bakery products.

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Giant Kew (GK)	Honey Queen (HQ)

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
Colour	Light yellow	yellow
Firmness	Fair	Good
Sweetness	Fair	Very good
Tartness	Strong	Fair
Overall acceptance	Moderate	Strong

* The values are means ±SD of three replicates

Table 2. Chemical properties of two pineapple varieties

Chemical properties	GK	HQ
Moisture content of fresh fruit (%)	84.42±0.05	83.95±0.02
Lipid content (%)	0.85±0.03	0.75±0.01
Protein (g %)	0.74±0.05	0.87±0.09
Total sugar content (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
Titratable 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

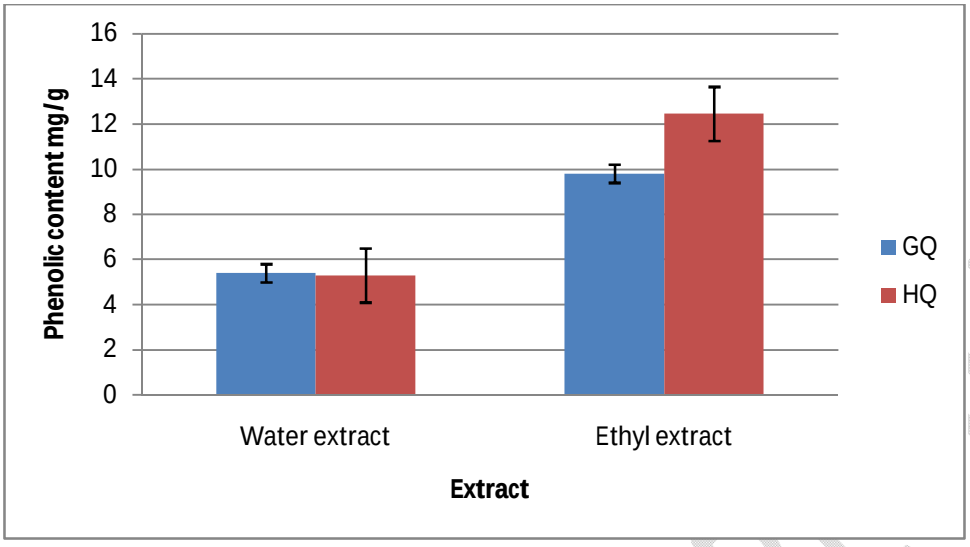

Figure 2. Phenolic contents (as caffeic acid equivalent) of pineapple extracts. The values are means ±SD of three replicates.

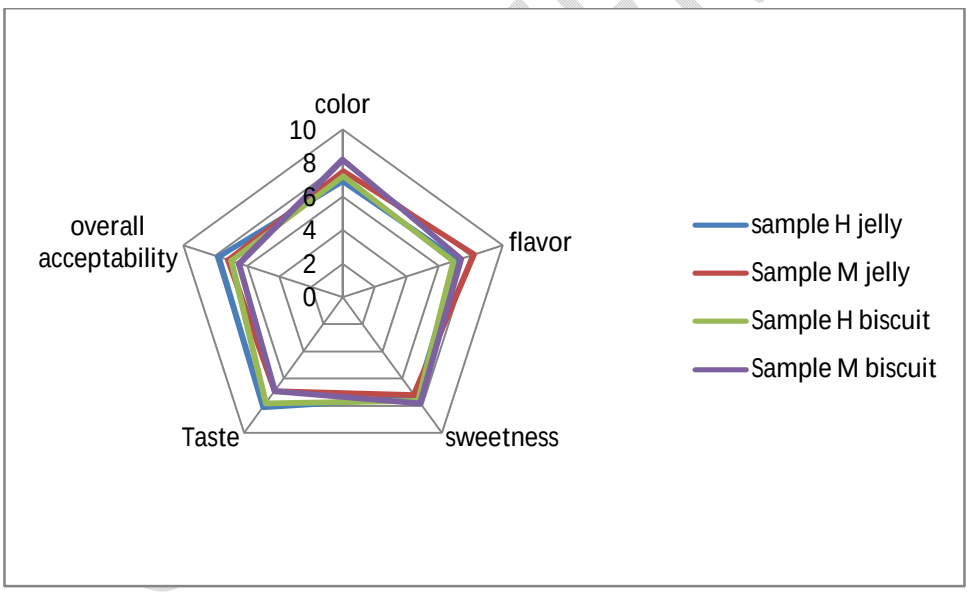

Figure 3 . Sensory evolution result of pineapple jelly and biscuit (Homemade- Sample H, Market- Sample M). The values are means ± SD of three replicates.

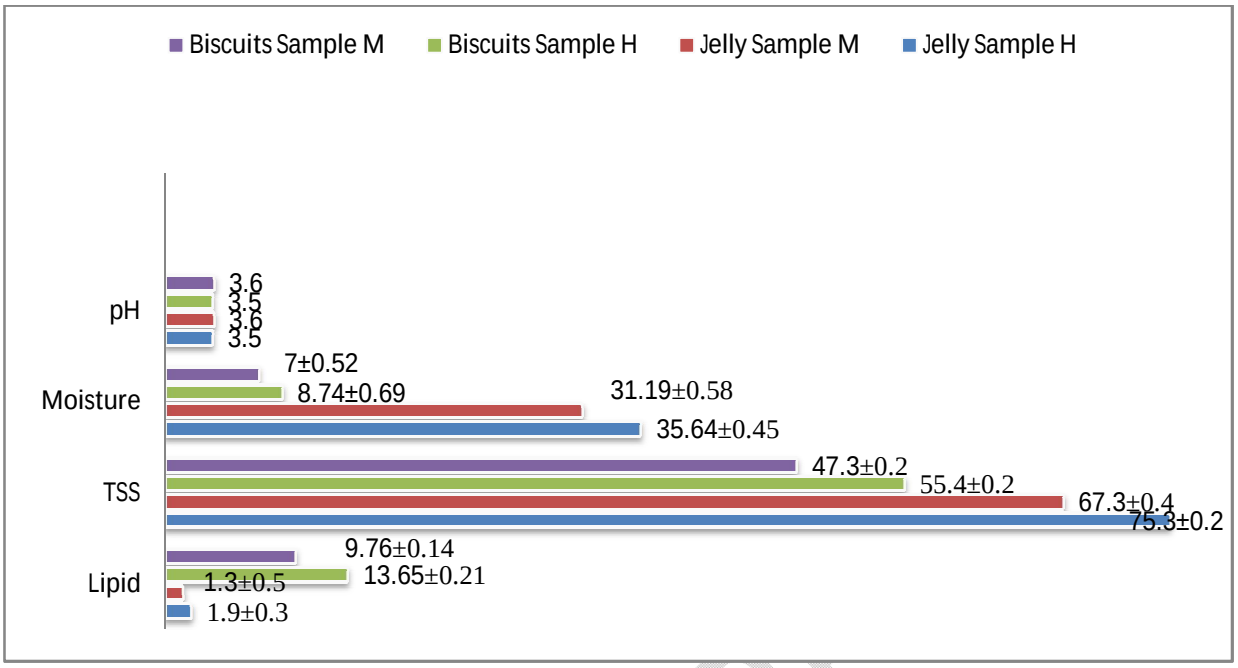

Figure 4 . Physiochemical properties of Sample H pineapple Jelly and biscuits in compared with Sample M. The values are means ±SD of three replicates.