INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 5, No. 8, p. 37-46, 2014

RESEARCH PAPER OPEN ACCESS

Evaluation of organoleptic and physico-chemical parameters of different apple verities commonly grown in district Gilgit, Northern Pakistan

Maqsood Hussain[1], Tika Khan[1*], Zulfiqar Ali[2], Syed Arif Hussain[3], Shamsher Ali[1], Maisoor Ahmed Nafees[1], Qamar Abbas[1]

[1]*Integrated Mountain Area Research Centre, Karakorum International University Pakistan*
[2]*Food and Agriculture Department Karakorum International University Gilgit Baltistan*
[3]*Department of Biological Sciences, Karakorum International University, Gilgit Baltistan*

Key words: Physic-chemical, Organoleptic, Apple, Karakorum, Medicinal, Varieties, Market.

http://dx.doi.org/10.12692/ijb/5.8.37-46 Article published on October 23, 2014

Abstract

Organoleptic and physico-chemical analysis was undertaken to analyze three apple varieties commonly found in the local market of district Gilgit, Pakistan. Different parameters investigated include moisture content, ash content, total soluble solids, pH value, acidity, reducing sugar, total sugar, mineral elements etc. Research revealed that moisture content in Golden Delicious-GD (87.71%) is higher than Five Star-FS (78.99%) and Nazak Badan-NB (84.81%). Ash content found 0.29% (GD), 2.89% (FS) and 0.35% (NB). Similarly, total soluble solids were 10.2 (GD), 11.4 (FS) and 9.5 (NB). Moreover, fat content in GD (1.24%), FS (2.13%) and 1.87% (NB). pH value recorded was 3.69 in GD, 3.89 in FS and 3.44 in NB. Acidity, in GD (0.285%), 0.19% (FS) and 0.15% (NB). Mean valves of reducing sugar in in GD, FS and NB were (10.70%, 15.13%, 12.53%) respectively. Furthermore, total sugar in GD (10.70%), FS (15.13%) and NB (12.53%).The chemical values of fruits showed a higher content of mineral elements and also a good quality for the products obtained from the local market of district Gilgit. Based on the results research recommends for Jam, Juice and pulp production without any health risk.

* **Corresponding Author:** Tika Khan ✉ tika.khan@kiu.edu.pk

Introduction

Apple is one of the commonly grown cash crops in Gilgit-Baltistan (Khan *et al.* 2013; Shedayi *et al.* 2011) and has a profound impact on poverty alleviation and income generation of pro-poor segment of mountain communities (Khudadad *et al.* 2013). Apple is one of the most important perennial long lived woody fruit crops of the world (Fleming, 2013; Velasco *et. al.* 2010; Anonymous, 2013a). Most of the cultivated apples belong to Malus × domestica (also known as *M. pumila*) species of Rosaceae family. The commercial apple is a hybrid species with a complex history of inter- and intraspecific hybridization. The genus Malus comprises 25–47 species (Robinson *et al.*. 2001).Based on their morphological traits and flavonoid similarities, the genus Malus consists upon five further sections i.e. Malus, Sorbomalus, Chloromeles, Eriolobus and Docyniopsis (Afandi 2012).Growing apples has become a science and has been named 'pomology' (USDA, 2013) Central Asia is supposed to have maximum apple diversity (Harris 2002).

In Pakistan, it is grown as acommercial crop in Punjab,Khyber Pakhtunkhwa, Quetta and Gilgit Baltistan (Akhtar *et al.*. 2013; Akhtar *et al.* 2011). In Gilgit Baltistan, Hunza is famous for healthy heavenly varieties of Apple. It is fourth important cash crop in the world (Janick *et al.* 2013). China being the first for apple production annually and Pakistan falls on 11. (Javed 2013; Afandi 2012; Khair *et. al.* 2006).

Apple has great nutritional value and contains lots of nutrients including vitamin C, Potassium and fiber. Large number of nutrients is also present in peel (Boyer and Liu, 2004). It also contains essential food elements such as sugar 11%, proteins 0.3%, nearly 14% of apple is made up of carbohydrates, 4% vitamins and minerals and remaining part contains 80% of water (Whitney and Rolfes 2007; Potter and Hotchkiss 1998). A normal sized about 40 calories of energy and 1kg apples contain about 2100kj of energy (Anonymous, 2013). Apple has also the third highest anti-proliferative activity compared to other fruits (Boyers and Liu 2004).

Apple is effective for maintaining health. Itis also helps to relief body from diarrhea, constipation, cancer, diabetes,dysentery,fever, heart problem, Alzheimer, reduce chances for gallstones formation etc. (Kunkel *et al..,* 2012; Vasu 2013; Guhr and Lachance 1997; Khan 2009; Gerhauser, 2008; Khair *et al..* 2006).Apple is also used for treating arthritis and rheumatism (Vasu 2013). Apple contains good healing power. It is easy to digest and to remove acidity.

Different varieties of Golden, Yellow and Red Apple ripe in the month of September. Many farmers produce this commercially important produce mainly for the fresh market (Way and McLellan 1989).Across the globe, apple is processed into five basic main products i.e. juice, canned, puree, caned slice, dried apple and frozen slices. Sometimes, it is also processed into vinegar, jelly, apple butter and fresh slices (Lorenzo, 2009).

This study was aimed at investigation of physic-chemical and organoleptic characters of different apple varieties grown commercially in the area. These verities are commonly available in the markets of Gilgit-Baltistan and many poor farmers depend on the production and sale prices in the local markets. This study will helpe to understand their nutritional value and level of safety for human consumption and development of many other apple oriented products.

Materials and methods

Fully mature and healthy apple (*Malus domestica*) verities i.e. Golden Delicious, Five Stare and Nazak Badan were collected from local market of Gilgit-Baltistan, Pakistan. Fruits were thoroughly washed to remove dirt, dust and other pesticide residues and micro flora on the surface of the fruit.

Pulp extraction

Apples were passed through an apple pulper to separate pulp from the stones and skin. Pulp so obtained was used for Physico-chemical tests and for product development.

Physico-chemical Analysis

Moisture, Ash Total Soluble Solids

Moisture, ash and total soluble solid contents were determined by using A.O.A.C (1984).Fruit crushed sample (10g) was taken in a dried China dish. The dish was then allowed in oven at 60°C for 24 hours until a constant weight was obtained. To determine ash content, 2g sample was taken in a dry clean china dish and charred over a slow burning flame. The sample was then placed in the muffle furnace and ashed at 550°C until constant weight was obtained. TTS was determined using hand refractrometer at room temperature.

Fat Content (FC), pH and Mineral Content (MC)

FC

Fat content and pH was also detected using standard procedures described by the A.O.A.C (1984). Dry extraction method for oil determination was applied which was consisted of extracting dry sample with some organic solvent, since all the fat materials e.g. oils, phospholipids, sterols, fatty acids, carotenoids pigments, chlorophyll etc. were extracted together, therefore the results are frequently referred to as crude oil. Oils were determined by intermittent sox let extraction apparatus. Moisture free sample (10g) was taken in fat-free thimble and plugged with absorbent cotton wool and placed in the apparatus. A previously cleaned and dried 250 ml round flask was weighed and filled one third or 120 ml with petroleum ether. Then extraction started and continued for 3-4 hours or at least siphoning for 6-10 times. Then turned the apparatus off, and removed completely the ether solvent from oil by evaporation. Placed the flask in an oven at 105°C for at least one hour, and then cooled. Cool the flask in a dedicator and weigh the flask and contents.

pH

pH of the samples was determined by using Inolab Digital pH meter. pH meter was standardized with standard buffers of pH and 9.0, and before taking each reading electrodes were washed with distilled water and then dried with soft tissues paper. The electrode is simply dipped in sample till the pH meter gives final reading that is considered being the pH value of sample.

MC

To determine the mineral contents (N, K) from the sample, the diluted samples were introduced to Flame photometer. Following procedure was adopted to achieve the goals;

1. Prepare by dilution of the stock standards 20, 15, 10 and 5 ppm Na and K standards. De-ionized water is the blank solution.
2. To 10 ml of the fruit juice, 50 ml de-ionized water was added.
3. Filter this solution through an ash less filter paper (e.g. Whatman 540) into a liter volumetric flask. Ensure that the solid particles retained by the paper are washed thoroughly and washings directed into the same 1 liter flask. Dilute to the mark with de-ionized water, stopper the flask and mix by inversion.
4. Set up the flame photometer as outlined in its instruction manual for sodium.
5. Set blank to zero, i.e. de-ionized water.
6. Aspirate the standards and record their stable readings.
7. Aspirate the sample solution into the flame photometer.
8. Adjust the filter position to select the potassium filter and repeat stages 5 to 9 for potassium.

Calculation

Multiply the concentration of Na and K obtained from the graph by the dilution factor, i.e. x 100, to express the result in ppm or mg/l of Na or K in the original fruit juice.

Reducing Sugar (RS), Non Reducing Sugar (NRS) and Total Sugar Analysis TSA)

RS

Fruit grounded sample (5g) while 5ml for liquid sample was taken separately and distilled up to 100ml with distilled water. The burette was filled with this solution. Then 5ml of Fehling A and 5ml of Fehling B solutions along with 10ml of distilled water were taken in a conical flask and boiled. On boiling it was titrated against the sample solution from the burette till color changed to red. It was tested with Methylene

blue as indicator till red color persisted. The ml of sample used was recorded and percent reducing sugar was calculated by using the following formula:

X ml of sample contains 0.05g of reducing sugar 100ml of sample solution contains $\frac{100 \times 0.05}{}$ = Y g of reducing sugar X ml.

This 100ml of sample solution was prepared from 5g sample. So 5g sample contains Yg of reducing sugar. % of reducing sugar in sample = Y× 100/5.

NRS

Non reducing sugar was calculated by subtracting the amount of reducing sugar from the total sugar as under:

Non reducing sugar = total sugar – reducing sugar.

TSA

Fruit grounded sample (10g) while 10ml for liquid sample were taken and diluted up to 100 ml with distilled water. From this solution 20 ml was taken in a flask and 10 ml of 1 N HCl was added and boiled gently in a water bath to invert the sugars , then cooled and neutralized with 10 ml 1N NaOH solution . Volume was made 150 ml with distilled water. The burette was filled with this solution. Then 5 ml of Fehling A and 5 ml of Fehling B solutions along with 10 ml of distilled water were taken in a conical flask and boiled. On boiling it was titrated against the sample solution from the burette till color changed to red. It was tested with Methylene blue as indicator till red color persisted. Total sugar was calculated by using the formula as under:

X ml of sample solution contains = 0.05 g of total sugar 250 ml of sample solution contains = $\frac{250 \times 0.05}{}$ = yg of total sugar X ml.

This 250ml of sample solution was prepared from 20 ml of original 10% of sample solution.

So 20 ml of 10% sample solution contains Yg of total sugar.

100 ml of 10% sample solution contains = Y×100 /20= Pg of total Sugar.

This 100 ml was prepared from 10 ml sample. So 10 ml of sample solution contain Pg of total sugars 100 ml of sample solution contains = $\frac{P \times 100}{}$ = Qg of total sugar. 10.

Total Titratable Acidity

The total titratable acidity was determined by standard method of A.O.A.C. (1984), by titrating against standard alkali solution. Burette stand, 50ml Burette, Conical flasks, volumetric flasks, Filter cloth, Distilled water, funnel, Graduated cylinder, and 10-ml sample. Following reagents were used;

NaOH (0.1N). Dissolved 4.5 g pellets of NaOH in one liter distilled water.

Oxalic acid (0.1N). Dissolved 6.3 g oxalic acid in one liter distilled water.

Fruit sample (5g) was taken in 100 ml volumetric flask and the volume was made with distilled water up to 100 ml. Then diluted sample (10 ml) was taken in a conical flask and added 2-3 drops of phenolphthalein as an indicator then titrated against 0.1 N NaOH solution. The end point is appearance of light pink color and the color was persisted for15-20 second. The ml of 0.1N NaOH used was recorded for all the samples and acidity was calculated as under:

$$\% \text{ Acidity} = \frac{F \times T \times N \text{ of NaOH} \times 100 \times 100}{L \times M}$$

Where:

F = Factor of acid (Malic acid)

T = ml of 0.1N NaOH solution used.

L = sample taken in g for dilution.

M = ml of diluted sample taken for titration.

Product Development

Selected cultivars of apple (Golden Delicious, Five Star, Nazak Badan) were used to prepare apple pulp jam.

Ingredients and Equipment

Three main ingredients and equipments are needed for making a good jam.

*Sugar (1kg).

*Acid (citric acid, sodium benzoate, potassium Meta bisulphate, 250mg).

*Apple pulp (250g).
*Jar funnel and Jars.

Determination of the end point when boiling a jam
Following method was used to determine the end-point of boiling jam.

Make a drop test
Take a small portion of the jam on a spoon, cool it slightly and drop it into a glass of water. If the drop falls in a single piece until it reaches the bottom, the end point has been reached.

Sensory Analysis of Product Development
To evaluate the sensory characteristics three products were developed from fresh apple varieties.

1. Apple (Golden Delicious) jam preserved with citric acid (250mg).
2. Apple (Five Star) jam preserved with citric acid and Sodium Benzoate(250mg)
3. Apple (Nazak Badan) jam preserved with 250mg citric acid and potassium metabisulphite (250mg).

The sensory evaluation of the products made from fresh fruits were analyzed by a panel of seven judges selected from staff and students of Food Science Department for sensory evaluation for color, flavor, mouth feel, viscosity and overall acceptability using hedonic scale in accordance with the method described by Larmond (1977). The panel members were selected on the basis of their ability to discriminate and scale a broad range of different attributes of apple products. An orientation program was organized for the panel members to brief them the objective of the study. The drink samples were brought to the sensory analysis lab and were served to the panelists. The judges were provided with prescribed questionnaires to record their observation. The information contained on the Performa was 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 panelists expectorated the products and rinsed mouth using distilled water between samples.

Results and discussion

Physico-Chemical Analysis

Total Soluble Solids (Brix°)

While analysis of total soluble solids (TSS) of three apple varieties using refractometer following results were obtained. 10.5° was observed in Golden Delicious, 11.4° in Five Star variety and 9.5°in Nazak Badan. High level of TSS 11.4° was observed in apple cultivar (Five Star) presented in Table 1. These results were correlated with previous work of Vieira *et al*.., 2009 revealed TSS in apple varieties between 12.7° to 14.0°. Durrani *et al*.., 2010 reported TTS valves in apple verities were 9 and 10 °, which is in agreement with our result. Likewise Chakespari *et al*.., 2010 said the TTS in different apple cultivars varied between 8.5 to 11.3°. Likewise Sestras *et al*.,.2009 said that TTS in different apple cultivars exist between 13.7 to16.4°. Similarly TTS recorded in some apple verities varied between 14.5 to15.7° reported by Laplace et. al. (2001).

Moisture Content (%)

The moisture content in apple varieties recorded was; Golden variety 87.71%, in Five Star 78.99% while Nazak Badan contained 84.81%. Highest moisture content recorded was 87.71% (Golden Delicious) presented in table 1. The earlier work on moisture content in apple varieties was; 84.11% by Trejo-González*et al*., 1991. Similarly Campeanu *et al*., 2009 said that the moisture content in apple varieties may exist between 76.67 to 88.37%. Ghadge *et al*., 2008 reported moisture content in apple was 84.20%. Chakespari *et al*., 2010 reported the finding of moisture content maximum 86 and minimum 84.93% in apple cultivars. Maximum moisture content 86.40 and minimum 79.55% in apple verities reported by Kheiralipour *et al*., 2008. Similarly Enidiok,.2010 reported moisture content 83.69%.

Similarly moisture content in some apple verities recorded was varied 83.16 to 86.42% reported by Mukhtar *et al*., 2010. Above results are in agreement with our findings of moisture level in apple cultivars.

Ash (%)

While analysis of ash of three apple verities following results were obtained. 0.29% in Golden Delicious, 2.89% in Five Star and 0.35% in Nazak Badan. High level of ash content was recorded in Five Star (2.89%) while low level of ash was recorded in Nazak Badan (0.35%), presented in table 1. These results were correlated with previous work of Trejo-Gonzalez *et al.*,1991 reported ash content 0.35% in apple verity. Similarly Mukhtar *et al.*, 2010 said that ash content in apple verities exist between 1.50 to 2.54%. Same like Campeanu *et al.*, 2009 reported ash content in apple cultivars between 1.63 to 2.88%. Climatic conditions also effect apple composition. Above discussion showed that our results are in agreement with previous findings.

Table 1. Moisture, ash content, TSS and fat content of three apple cultivars.

S. No	Cultivars	Moisture %	Ash %	TSS (°Brix)	Fat %
1	Golden Delicious	87.71	0.29	10.2	1.24
2	Five Star	78.99	2.89	11.4	2.13
3	Nazak Badan	84.81	0.35	9.5	1.87

Research work was carried out to compare physico-chemical analysis of pulp of three fresh apple verities (Golden Delicious, Five Star, Nazak Badan) and sensory evaluation of these cultivars grown in Gilgit Baltistan Pakistan, as discussed below.

4.1.4 Fat (%)

While analysis of fat percentage in apple verities recorded was 1.24 in Golden Delicious, 2.13 in Five Star and 1.87 in Nazak Badan. High level of fat content was observed in Five Star (2.13%) presented in Table.1. Our results are correlated with the previous work of Mukhtar *et al.* (2010) reported fat content in various apple verities exist between 1.00 to 2.21%. Above results were related to our observations.

pH

pH valves in apple verities recorded were 3.69 in Golden Delicious, 3.89 in Five Star and 3.44 in Nazak Badan. Highest level of pH recorded was 3.89 (Five Star), while lower level was 3.44 (Nazak Badan) presented in Table.2. These were correlated with previous work of Durrani *et al.* (2010) reported pH valve in some apple 3.55 to 3.74 which is in agreement with our results. Similarly Vieira *et al.* (2009) reported pH valve in apple cultivars exist between 3.90 to 4.27. Similarly in another work by Enidiok and Attah (2010) reported pH valve in two apple verities 3.68 and 3.79. Similarly, pH valve in apple cultivars between 3.93 and 4.14 reported by Laplace *et al.*(2001). Shukla *et al.* (2003) reported 4.13 pH values in apple pulp. This is in agreement with our results. In another work maximum pH valve was recorded 4.2 while minimum pH recorded 3 in apple cultivar reported by Chakespari *et al.*(2010).

Table 2. pH, titratable acidity (TA), total sugar (TS), reducing sugar (RS) and non Reducing sugar of three apple cultivars.

S.#	Cultivars	pH	Acidity (%)	TS (%)	RS(%)	NRS (%)
1	Golden delicious	3.69	0.28	71.20	10.70	60.31
2	Five Star	3.89	0.19	65.52	15.13	50.22
3	Nazak Badan	3.44	0.15	67.93	12.53	55.43

Titratable acidity (%)

While analyses of total acidity of three apple cultivars following results were obtained 0.28% in Golden Delicious, 0.19% in Five Star and 0.15% in Nazak Badan presented in Table.2. Chakespari *et al.* (2010) reported maximum acidity level in apple cultivars 0.27 and minimum 0.012% similarly in another work, total acidity was reported in apple cultivars exist between 0.20 to 0.36% reported by Vieira *et al.* (2009). Like Durrani *et al.* (2010) reported total acidy

in apple verities between 0.29 to 0.33%. Above findings of titratable acidity in apple verities correlated with our results.

4.1.7 Reducing Sugar (%)

Reducing Sugar in three apple verities recorded was 10.70% in Golden Delicious, 15.13% in Five Star and 12.53% in Nazak Badan presented in Table.2. Our results were correlated with previous work of Vieira*et al.* 2009 recorded total sugar between 9.53 to 12.34% in apple cultivars. Total sugar level in different apple verities exist between 5.71to 7.15% reported by Adamczyk *et al.*, 2005.

Table 3. Mineral Content (mg/100g) of three Apple cultivars.

S.No	Cultivars	Mineral content (ppm/L)	
		Sodium (Na^+)	Potassium
1	Golden Delicious	0.8	160
2	Five Star	0.6	178
3	Nazak Badan	0.4	155

Total Sugar (%)

While analysis of Total Sugar level of three apple cultivars following results were obtained. 71.20% in Golden Delicious, 65.52% in Five Star and 67.93% in Nazak Badan presented in Table 2. Our results are correlated with previous work of Shukla *et al.* 2003 reported total sugar level in apple fruit was 101.42%. Same like Phillip *et al.* 1991 said that the contribution of total sugars to total soluble solids ($Brix^0$) varied between 58.0% to 72.0% in apple verities.

Table 4. Sensory evaluation of fresh apple pulp jam

S #	Cultivars	Color	Flavor	Mouth- feel	Viscosity	Overall accept
1	Golden Delicious	7.4	7.2	8.2	7.5	7.7
2	Five Star	7.7	7.1	7.8	7.8	7.7
3	Nazak Badan	8	7.7	7.8	7.7	8

Non Reducing Sugar (%)

During analysis of non-reducing sugar of three apple verities following results were obtained. 60.31% was observed in Golden Delicious 50.22 % in Five Star and 55.43 5 was observed in Nazak Badan presented in Table 2. High valve of non-reducing sugar was observed in Golden Delicious while low valve was observed in Five Star cultivar.

4.1.10 Sodium (Na+)

the analysis of sodium content of three apple verities following observations were obtained, 0.8 ppm/L in Golden Delicious, 0.6 ppm/L in Five Star and 0.4 ppm/L in Nazak Badan presented respectively in Table.3. Our observations were correlated with previous work of Durrani *et al.* (2010) observed sodium content in apple cultivars exist between 0.41 to 0.71 ppm/L. Similarly Enidiok and Attah (2010) reported sodium content in two apple verities was 1.20 and 1.5ppm/L. Above findings of sodium content in apple fruit were related with our observations.

Potassium (K+)

Potassium content in three verities recorded were as following, 160 ppm/L in Golden Delicious, 178 ppm/L in Five Star and 155 ppm/L in Nazak Badan respectively presented in Table3. Our results are correlated with previous work of Durrani *et al.* (2010) reported potassium content in apple verities was between 101 to 180 ppm/L. In work potassium content was observed 117.0 ppm/L. These findings are related with our work.

4.2 Sensory evaluation of fresh apple pulp jam

Organoleptic evaluation of apple jam prepared from three apple verities i.e. Golden Delicious, Five Star,

Nazak Badan were carried out for color, flavor, mouth feel, viscosity and overall acceptability (Table 4).

Mean score for color observed were 7.4 in Golden Delicious apple jam preserved with citric acid, 7.7 in Five Star apple jam preserved with citric acid and Sodium Benzoate and 8 in Nazak Badan apple jam preserved with citric acid and potassium metabisulphite. The mean valve for flavor observed were 7.2 in Golden Delicious apple jam preserved with citric acid, 7.1 in Five Star apple jam preserved with citric acid and Sodium benzoate and 7.7 in Nazak Badan apple jam preserved with citric acid and potassium metabisulphite. While the mean valve for mouth feel observed were 8.2 in Golden Delicious apple jam with citric acid, 7.8 in Five Star apple jams with citric acid and sodium benzoate while same score was also observed in Nazak Badan apple jam. Same like mean valve observed for viscosity were 7.5 in Golden Delicious apple jam, 7.8 in Five Star and 7.7 in Nazak Badan apple jam. The overall acceptability for the products was 7.8 in Golden Delicious apple jam, 7.7 in Five Star apple jam and 8 in Nazak Badan apple jam.

The mean value for all three products together recorded were; color 7.7, flavor 7.3, mouth feel 7.9, viscosity 7.7 and overall acceptability 7.8. Maximum acceptability was found 8 in Nazak Badan apple jam preserved with citric acid and potassium metabisulphite, while 7.8 in Golden Delicious and 7.7 in Nazak Badan apple jam preserved with citric acid and potassium metabisulphite.

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