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DEVELOPMENT OF MULBERRY SQUASH AND IT'S EVALUATION

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Abstract : Mulberry (*Morus Nigra*), which belongs to the *Moraceae* family, is grown in worldwide. It also contain several nutritive compounds such as fatty acid, amino acid, vitamins, minerals and bioactive compounds including anthocyanins, rutin, qucretin, cholorogenic acid and polysaccharides. The study was undertaken to produce stable and organoleptically preffered mulberry squash with 25% of pulp and four different concentrations of total soluble solids i.e. TSS-42°Brix,TSS-44°Brix,TSS-46°Brix,TSS-48°Brix and 1% of acidity. Sodium benzoate was used as preservative. The sensory properties of squash was evaluated by a semi trained panelist members. The result showed that color, flavor, sweetness, consistency, mouthfeel and overall acceptability of squash S_3 containing 46°Brix got high score and other sample were moderately acceptable. The storage potential of squashes was observed. After 12 weeks S_1 , S_2 , S_3 and S_4 were slightly changed in TSS and acidity. . The minimum physico-chemical quality attributes were deteriorated in the squash due to the addition of preservative. Squash was found completely free from spoilage due to higher total soluble solids and effective processing of the product.

Key words **- Sensory Properties, Anthocyanins, Consistency, Total Soluble Solids(TSS), Physico-Chemical Properties.**

I. INTRODUCTION

Mulberry (*Morus* spp), which belong to *moraceae* family, is grown worldwide. Mulberries also contain severel nutritive compound such as fatty acid, amino acid, vitamin, minerals and bioactive compounds including anthocyanins, chlorogenic acid and polysaccharides. There are 24 species of Morus and one subspecies with at least 100 known varieties. The three most common commercial mulberry species include white mulberry (*Morus alba*), black mulberry (*Morus nigra*), red mulberry (*Morus rubra*). The black mulberry has been known with their high content total phenolies, total flavonoids and ascorbic acid (Hassimotto *et al*., 2007; Nitra *et al*., 2007). Mulberries are also an excellent source of iron which rate feature among berries. Iron,being a component of hemoglobin inside the red bloods cells determine the oxygen carrying capacity of the blood. Mulberry fruit juice in anthocyanins. The major components identified include cyanidine-3-glucoside and cyanidine-3-rutinoside (Sun *et al*., 2002; Lee *et al*., 2004).

The fruit of this plants have good impact on blood glucose level and can control blood cancer (Martin *et al*., 2008; Ahmed *et al*., 1985). Fruits are also used for preparation of pickle. It contains malic acid, citric acid, pectin, mucilage and coloring matter (Shivkumar *et al*., 1996; Singhal *et al*., 2010).

Squash is non-alcoholic concentrated syrup made from fruit juice, water and sugar substitute. Squash is mixed with certain amount of water before drinking. Fruit squash are becoming popular relative to synthetic beverage become their taste, flavour, nutritive value and storage stability (Tortoe C *et al*., 2014; Enwere NJ., 1998). Among all beverages squash is popular all over the world as nutritious soft drink (Carvalho Jaegar de LM *et al*., 2008; Enwewe NJ ., 1998). As per FSSAI specifications squash

should not contain less than 25 % fruit content in finished product and the total soluble solids content should not be less than 40° Brix. The acidity of the squash should not more than 3.5 % as anhydrous citric acid

Retention of food quality during storage depends on packaging and storage conditions of temperature, relative humidity and time (Lawless HT and Heyman H., 1998). The pH plays important role in acceptability and shelf life of foods. The lower the pH of food material the fewer the types of microorganism that can thrive in that food (Carvalho Jeager de LM *et al*., 2008). The critical factor affecting the spoilage of juices include pH, oxidation– reduction potential, water activity, availability of nutrients and presence of antimicrobial compounds (Lawless HT and Heyman H., 1998). Temperature used in the processing of foods eliminates organisms but may destroy heat labile vitamins such as vitamins C (Oyeleke GO *et al*., 2013).

Sensory evaluation is a key factor for determining the shelf life of many food products (Lawless HT and Heyman H., 1998). Sensory evaluation of pineapple squash would provide information on its acceptance while shelf life study would assess its safety for consumption and storage. However, sensory properties are influenced by method of preparation, formulation, processing and storage conditions (Oyeleke GO *et al*., 2013).

1.1 NUTRITIONAL VALUES:

Mulberry fruits are edible and well known for its delicious taste (Singhal et al., 2010). They can be consumed directly or can be used in the preparation of Wine, Jam or Soft drinks (Ye Z., 2001). Mulberry fruit juice has been commercially produced as a health beverage. The main content of fresh, ripe mulberry fruit is as follow:

Table No 1: Nutritional content of fresh mulberry fruit (Source : www.itmonline.org).

Parameters	**%**
Water	85 -88
Carbohydrate	7.8-9.2
Protein	0.4-1.5
Fat	0.4-0.5
Free acids	1.1-1.9
Fiber	0.9-1.4
Minerals	0.7-0.9

Mulberries are literal powerhouse of nutrition. They are very rich in Vitamins B, C, K and the element iron. Good levels of fibre, riboflavin, phosphorus, copper, magnesium, potassium and calcium are also found in mulberries (Fairjuice., 2008). It also helps people who suffer from dehydration. It also promotes the melanin production in hair and helps to maintain the natural colour of the hair. People with grey hair can also benefit with regular intake of mulberry. Mulberry juice applied directly on the hair can revive the hair roots and stimulate healthy hair growth again. It has a high content of vitamin A which strengthens our eye sight and relieves eye strain which is ideal for people who spend hours on computer (Tanakij T and Pilairuk I., 2004).

2. MATERIALS AND METHODS

The raw material for preparation of squash i.e. mulberry fruits were collected from the Sambha agro farmer producer company, Nashik. Sugar and preservatives were purchased from local market of Shrigonda. The Study was carried out in at the Department of Food Process Technology, in SCFT,Ghargaon, Shrigonda, Ahmednager(MH).

Table No 02 : Formulation of Mulberry Squash

Sr.No	Ingredients	Sample No	TSS(°Brix)
1	Juice+Sugar Syrup+Preservative	Sample No 1	**42**
2	Juice+Sugar Syrup+Preservative	Sample No 2	**44**
3	Juice+Sugar Syrup+Preservative	Sample No 3	**46**
4	Juice+Sugar Syrup+Preservative)	Sample No 4	**48**

Figure No 01: Formulation of Mulberry Squash

2.1 Preparation of Mulberry Squash

Fresh mulberry fruit was used for extraction of juice. The mulberry was weighed and juice was extracted using quality electric juicer. Then juice was filtered by muslin cloth and mulberry squash was prepared by following the recipe recommended by Awan and Rehman (2004), During preparation of squash the standard preservative sodium benzoate was used. Mulberry squash was prepared with juice and four different concentrations of TSS as shown in table no 1.

2.2 Sensory Evaluation

Quality of mulberry squash was evaluated for sensory characteristics (color, taste, flavour, mouthfeel and overall acceptability) during storage on hedonic rating scale by a semi trained panellist members.

.2.3 *Physico-Chemical analysis*

The physio-chemical attributes like pH, acidity and total soluble solids were analysed to assess the quality of squash. The total soluble solid (TSS), titratable acidity and pH was determined by the standard method of AOAC (2000).

2.4 Microbiological Evaluation

Microbiological analysis of squashes was performed by following the method of Harrigan (1998). The samples were prepared by 10 fold serial dilution and the total viable count was estimated by using nutrient agar as medium. The colonies were manually counted.

3. RESULT

The research was conducted to study the quality parameter of mulberry squash by physico-chemical and sensory parameter during storage period. The four different types of squash were prepared with different concentration of Total Soluble Solid (TSS).

3.1 Sensory Analysis

Table No 3: Sensory Attributes of mulberry squash

Sample	Sensory Attributes					
	Color	**Flavour**	**Consistency**	**Taste**	**Mouth Feel**	**Overall Acceptability**
S_1	7.0	7.8	7.7	7.0	7.2	7.3
S_2	7.2	7.6	7.4	7.6	8.0	7.5
S_3	8.0	8.2	7.8	8.4	8.2	8.1
S_4	7.8	8.0	7.6	7.8	8.2	7.8

The four squashes were judged by a semi trained panel of 10 judges. The mean score for colour, flavour, consistency, mouthfeel, taste, overall acceptability of the sample were evaluated and the mean score of the responses are presented in the table.

Squash S_3 has shown the better colour and acceptability than other squashes (Table No.2). The flavour of squash of S_3 was most preferred than other squashes. In comparison of flavour, squashes S_3 and S_4 were better than squashes S_1 and S_2. Among all sample of squashes, flavour of S_1 sample was less acceptable. Consistency of the squash S_3 was most preferred and significantly different than other squashes. The mouth feel of squash S_3 and S_4 were significantly better than other squashes. The S_1 has shown less mouth feel and acceptability among sample. Among all sample of squashes, taste of S_3 and S_4 were most preferred than other sample.

Overall acceptability of squash S_3 was most preferred and significantly different than other squashes S_1, S_2, and S_4. The sample S_1 and S_2 had shown least satiety when compared with other squashes.

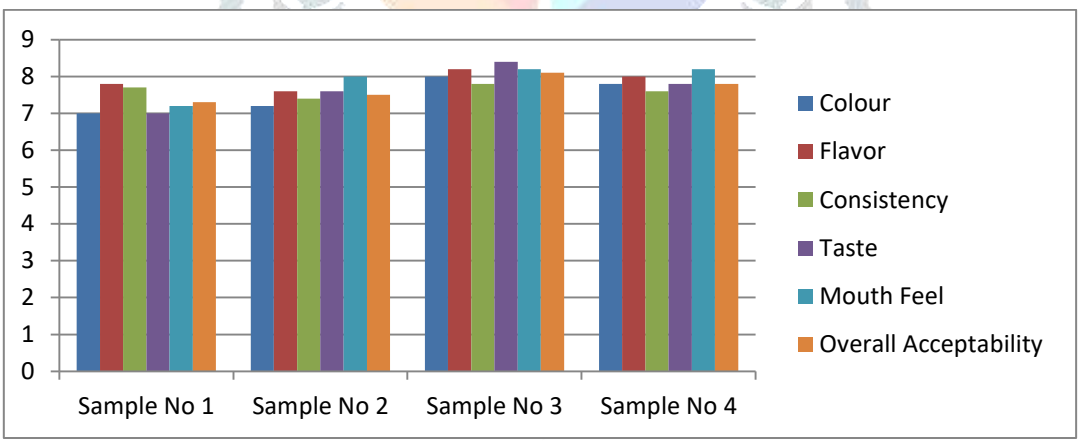

Figure No 02: Sensory Evaluation of Mulberry Squash

3.2 Nutritional Analysis

Sample 3 (25% of pulp, 48°Brix, 1% acidity) has got high ratings during sensory evaluations, so only sample no 3 was taken for a nutritional analysis. The result of nutritional analysis is as shown in table no 05.

Table No 4: Nutrient content of mulberry squash

Sr.No	Test Parameters	Result	Units
1	Total Fat	0.17	g/100 gm
2	Protein	0.41	g/100 gm
3	Carbohydrate	54.02	g/100 gm
4	Energy Value	219.2	Kcal/100 gm
5	Vitamin C	14.6	mg/100 gm

Table No 5: The storage study on the chemical analysis of mulberry squash

		Storage Period (Days)					
Parameter	**Treatments**	**0**	**15**	**30**	**60**	**90**	**Mean**
°Brix	S_1	42.09	42.78	43.88	43.98	44.01	**43.34**
	S_2	44.25	44.55	45.67	45.78	45.90	**45.23**
	S_3	46.23	46.44	46.98	47.00	47.58	**46.84**
	S_4	48.02	48.78	49.02	49.45	49.78	**49.01**
	Mean	**45.14**	**45.63**	**46.38**	**46.55**	**46.81**	
Acidity(% Citric Acid)	S_1	1.02	1.00	0.98	0.97	0.95	**0.98**
	S_2	1.03	1.01	0.99	0.97	0.94	**0.98**
	S_3	1.05	1.03	1.01	0.98	0.96	**1.00**
	S_4	1.04	1.02	0.99	0.97	0.94	**0.99**
	Mean	**1.03**	**1.01**	**0.99**	**0.97**	**0.94**	
PH	S_1	4.58	4.62	4.65	4.68	4.69	**4.64**
	S_2	4.61	4.65	4.67	4.70	4.72	**4.67**
	S_3	4.56	4.59	4.60	4.63	4.65	**4.60**
	S_4	4.58	4.59	4.62	4.65	4.66	**4.62**
	Mean	**4.58**	**4.61**	**4.63**	**4.66**	**4.68**	

3.3 Brix

The result revealed that the effect of treatment and storage period was found to be highly significant on Brix of mulberry squash. Total soluble solid (TSS) initially adjusted in formulation S_1,S_2 ,S_3 and S_4 showed a negligible change throughout the 90 days storage period at room temperature. It was observed that the range of TSS increased this range was similar to range as repeated by Rangana (1979). The percentage change of TSS is greater in last two weeks (11^{th} and 12^{th} week) than other weeks and it is due to conservation of carbohydrate and acid into sugar.

3.4 Titratable acidity

The result revealed that the effect of treatments and storage period was found to be highly significants on the acidity of mulberry squash acidity was calculated on the basis of titratable acidity of all formulation varied directly with storage period and it was gradually decrease. The acidity of various fruit squashes were within the range of 1.05 to 0.96 %. This implies that the amount of mulberry fruit juice affected the acidity of the squash. The acidity of sample S_3 and S_4 were more acidic than S_1 and S_2 (Table No 3).

3.5 pH

The result revealed that the effect of treatment and storage period was found to be highly significant on the pH of mulberry squash. The variation in pH were observed through out 90 days storage period in all formulation. The relationship between pH and acidity is interrelated. The lower the acidity. The higher the pH occurred during the storage period at room temperature S_1 and S_2 has lower pH than squash S_3 and S_4 (Table No 3). The change in pH is associated with number of reason. It might be due to effect of heat treatment on the biochemical condition of fruit and vegetable and slower rate of respiration and metabolic acidity (Jitareerat *et al*.,2007).

3.6 Microbiological analysis

Table No 6: Microbial Analysis of Mulberry Squash

	Storage period (Week)	**SPC (log cfu/g)**	**Coliform (log cfu/g)**	**Yeast and Mold (log cfu/g)**	**TPC (log cfu/g)**
S_1	0	3.45	Absent	Absent	Absent
	2	3.48	Absent	Absent	Absent
	4	3.50	Absent	Absent	Absent
	8	3.54	Absent	Absent	Absent
	12	3.55	Absent	Absent	Absent
S_2	0	3.42	Absent	Absent	Absent
	2	3.45	Absent	Absent	Absent
	4	3.48	Absent	Absent	Absent
	8	3.52	Absent	Absent	Absent
	12	3.56	Absent	Absent	Absent
S_3	0	2.78	Absent	Absent	Absent
	2	2.78	Absent	Absent	Absent
	4	2.77	Absent	Absent	Absent
	8	2.72	Absent	Absent	Absent
	12	2.80	Absent	Absent	Absent
S_4	0	2.21	Absent	Absent	Absent
	2	2.24	Absent	Absent	Absent
	4	2.26	Absent	Absent	Absent
	8	2.28	Absent	Absent	Absent
	12	2.31	Absent	Absent	Absent

The result shown that the storage period was highly significant on the microbial count of mulberry squash. The microbial status of the mulberry squash showed value of viable count of S_1 (3.55 log CFU/g), S_2 (3.56 log CFU/g), S_3 (2.80 log CFU/g) and S_4 (2.31 log CFU/g) respectively. The storage period on the microbial count of the mulberry squash revealed that the microbial count gradually increased with increment in storage period. However, lower microbial load was observed in S_4 (25% of pulp, 48°Brix, 1% acidity) i.e. 2.21 to 2.31 CFU/gm . There is no growth in coliform, yeast, mold and TPC. The result clearly indicated the presence of antimicrobial potential due to addition of preservatives.

4. DISCUSSION

In general, total soluble solids of mulberry squash increased during storage(Table no 3). This might be due to increase in total soluble sugars produced during hydrolysis of polysaccharides like starch, cellulose and pectin substances into simpler

substances. Maximum increase in TSS was noticed in treatments S_3 (25% of pulp, 46 °Brix, 1% acidity) and S_4 (25% of pulp, 48 °Brix, 1% acidity). Mulberry squash showed an in pH during storage. Maximum increase in pH was noticed in treatment S_1 (25% of pulp, 42 °Brix, 1% acidity) i.e. 4.58 to 4.69 . Minimum increase in pH was noticed in S_4 (25% of pulp, 48 °Brix, 1% acidity) i.e. 4.58 to 4.66. The increase in pH of Mulberry squash during storage could be attributed to acid hydrolysis of polysaccharides and non-reducing sugars to hexose sugars (reducing sugars) or complexing in the presence of metal ions as reported in aonla juice (Gajanana, 2002).As the pH increases the acidity decreases, the minimum decrease in acidity was noticed in the treatments S_1 (25% of pulp, 42°Brix, 1% acidity) i.e. 1.02 to 0.95 and maximum increase in acidity was noticed in the treatments S_4 (25% of pulp, 48°Brix, 1% acidity) i.e. 1.04 to 0.94 at 90 days of storage period. Mulberry squash prepared with different concentration of TSS was found completely free from spoilage due to higher total soluble solids and effective processing of the product. Settlement of pulp particles at the bottom of bottles was noticed in the all treatments.

So from the Quality evaluation of Mulberry Squash it was observed that mulberry juice preserve the quality and shelf life of mulberry squash for the storage period of 90 days.

5. CONCLUSION

It can be concluded from the present experiment that we can utilize the mulberry squash for preparation of ready to serve drink. The preparation of mulberry squash with the sample no 3 consisting 25 percent pulp 46 percent TSS and 1.0 percent titratable acidity was significantly best over the rest treatment and can be stored successfully for 3 months at ambient condition.

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