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Effect of pomegranate juice and sugar on sensory qualities of pomegranate-based whey beverage

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Abstract

Whey is a valuable by-product obtained during manufacture of cheese, chhana, paneer, casein and Shrikant in dairy industries and usually dumped because it has no value; on the other hand, the whey presents interesting nutritional value as food supplement and its discard is increasingly frowned upon by environmentalists. Whey has been considered as an important food medium for thousands of years. It is rich source of carbohydrates (Lactose 4-5%), minerals 0.60% (Ca, P, Na, Mg etc.), and whey proteins α lactalbumin (22% of whey protein), β - lactoglobulin (59% of whey protein), serum albumin-6% of whey protein) and water-soluble vitamin i.e., B complex.

The conversion of whey into beverages through fermentation or without fermentation is one of the most attractive avenues for the utilization of whey for human consumption. Beverages based on fruit and milk products are currently receiving considerable attention as their market potential is growing. Besides being delicious, these beverages are highly nutritious.

Pomegranate is a well-known fruit for its nutritional composition as well as for its medicinal properties. Pomegranate is full of vitamin E (anti-oxidants), which helps to combat many diseases and also enhances the immune system. It is an abundant source of magnesium.

Pomegranate juice has strong anti-bacterial and antimicrobial properties which help fight viruses and bacteria and boost our immunity system. It significantly reduces microbes that are found in the mouth commonly responsible for cavities and staph infections. Anemia is a condition caused by the deficiency of red blood cells in the body. Since Pomegranate juice contains ample amount of iron it helps in surmounting a deficit of red blood cells in the body. Whey beverages are suitable for wide range of consumers from children to the oldest ones. Whey have not only high nutritive value but also have good therapeutic characteristics. Incorporation of pomegranate juice in whey beverage can enhance the nutritional and therapeutic value for it. Hence considering these points in a view, the effort has been made to prepare the pomegranate-based whey beverage from cow and goat milk. During the phase of investigation, optimization of ingredients viz. selection of level of pomegranate juice and selection of level of sugar for pomegranate-based whey beverage preparation were carried out.

During optimization study it was found that when pomegranate juice was added in different concentration and sugar was added in different percentage exerted a significant ($p < 0.05$) difference on all the sensory attributes under study. The overall acceptability score for all treatments were 7.73 ± 0.01 , 7.93 ± 0.01 , 7.63 ± 0.03 , 7.94 ± 0.02 , 8.13 ± 0.01 , 7.84 ± 0.02 , 6.40 ± 0.06 , 6.52 ± 0.03 , 6.33 ± 0.01 respectively and maximum score was obtained for pomegranate-based whey beverage prepared using pomegranate juice used @ 14 percent and sugar @ 8 percent.

Keywords: Whey beverage, sugar, pomegranate juice, sensory evaluation

Introduction

Whey is a valuable by-product obtained during manufacture of cheese, chhana, paneer, casein and shrikhand in dairy industries and usually dumped because it has no value; on the other hand, the whey presents interesting nutritional value as food supplement and its discard is increasingly frowned upon by environmentalists. Whey is the major by-product of the milk industry in the process of milk manufacturing products like Channa, paneer, Chakka, casein, cheese etc. During the process about 10-20 per cent portion of milk is recovered as the desired end product and the remaining 80-90 per cent liquid portion is the whey. Whey has been considered as an important food medium for thousands of year. It is rich source of carbohydrates (Lactose 4-5%), minerals 0.60 % (Ca, P, Na, Mg etc.), and whey proteins α lactalbumin (22% of whey protein), β - lactoglobulin (59% of whey protein), serum albumin-6% of whey protein) and water-soluble vitamin i.e., B complex Marshall (2004) [8] and Fluegel *et al.*, (2010) [9]. Milk and dairy products represent one of main diet of Indian people. As a sequel to white revolution, India has surged ahead to become the largest milk producer in the world.

With growing urbanization, demand for processed dairy foods has increased considerably, in particular demand for different cheese varieties and low-lactose milk due to increasing intolerance of human beings to lactose in milk and other milk products. Whey contains approximately half of the total solids of the original milk (Gupta, 2000) ^[17]. The total solids content of whey ranges between 6.5-7.0 per cent of which lactose comprises 75 per cent in addition to water soluble vitamins, minerals, and proteins. The presence of all these ingredients makes whey a highly nutritious base for the preparation of beverage like products. Cheese whey contains about 20 per cent of total milk protein Khamrui and Rajorhia (1998) ^[21]. The whey is an excellent source of high-quality proteins, minerals and easily digestible carbohydrates. Currently, total world production of whey is approximately 85 million tones in which India contributes approximately 5 million tons of the total global production. About 40 percent of the total global production of whey is disposed as raw whey Reddy *et al.* (1987) ^[25] causing serious problems of environmental pollution due to high organic matter content (6-7%) comprising of fat, protein, sugar, minerals and water-soluble vitamins. Biological oxygen demand of whey varies in the range of 45,000-60,000 ppm. Growing awareness and concern of the people towards pollution and environmental control legislation have renewed pressure on the dairy industry to discontinue introduction of whey into municipal sewerage systems and in the streams. At the same time pre-disposal treatment of whey is very costly affair as it influences the economics of dairy plant operation Kumar and Tiwari, (2005) ^[22]. The conversion of whey into beverages through fermentation or without fermentation is one of the most attractive avenues for the utilization of whey for human consumption. Beverages based on fruit and milk products are currently receiving considerable attention as their market potential is growing. Besides being delicious, the beverages are highly nutritious. In terms of functionality, whey protein enhances protein content of beverage while improving its quality. The production of a beverage from whey butter cheese and acerola juice has been shown to have good commercialization potential, uniting the benefits provided by the former with that of the latter, including the ingestion of essential amino acids and increasing vitamin C content, resulting in a product of differentiated nutritive value Cruz *et al.* (2009) ^[23]. Conversion of whey into a beverage on a commercial scale also has an economic advantage, as the whole quantity is being used and there are no problems of leftover residues Shendurse *et al.*, (2009) ^[24]. Beverages in general provide energy and water to digest food, regulate body temperature, prevent dehydration, quench thirst and remove psychological tensions, Market demand for beverages is growing all over the world including India. Fruit juices are well recognized for their nutritive value, mineral and vitamin content. They are beverages that are consumed for their nutritional value, thirst-quenching properties and stimulating effect or for their medicinal values.

The low pH of fruit juices greatly limits the number and the type of bacteria that can survive. At present bulk of the beverages are generally synthetic flavored, that are made available in market. If this could be substituted with fruit juice and dairy by product, results in beneficial contribution to the consumer, dairy industries and beverage manufacturers as well as fruit growers. Increased awareness in health issues leads to increase in the consumption of fruit juices and other

natural products as an alternative to the traditional caffeine containing beverages such as tea, coffee or other soft drinks. Accompanying the increase in quantity of consumption, there has been a parallel increase in the variety of fruit juices and beverages offered for sale in the market Gagrani *et al.* (1987) ^[20]. Soft beverage industry has made significant progress during the last two decades in terms of rise in production and consumption; however, there is a limited range of fruit juice based RTS beverages available in the Indian market. Many types of syrups and soft drinks containing artificial fruit flavors are well known throughout the world. The basic factor considered is the nutritive and therapeutic values, which make them popular and acceptable.

Pomegranate, the fruit of Punicaceae family is a shrub or tree that grows approximately 16 to 26 feet tall. *Punica granatum* is its scientific name. It is also named as seeded apple or Chinese apple. They are perfect winter foods, rich in fiber and rated among healthier fruits. Pomegranate is known for its quality of improving heart health, protecting against prostate cancer, help in preventing diabetes and are rich in antioxidants that help fight against cancers and free radical formation. Juice and seeds of pomegranate contain vitamins, potassium and antioxidants three times more than green tea. Seeds are mostly used as spice in Pakistani food as Anar dana. These seeds are dried and used in curry formation. Supplements are available as dried form but by drinking concentrated juice which contains polyphenolic antioxidants one can survive from blood pressure and high cholesterol level in the body. Edible part of fruit consists of 20 percent seed and 80 percent juice. In juice fructose and glucose are present in equal quantity. Polyphenol part consist of catechins, tannins, ellagic acid and anthocyanins. Its seeds are rich of pectin, sugars and fiber that benefits against heart diseases. Pomegranate reduces LDL cholesterol from the body and prevents against atherosclerosis Julie. Pomegranate has been used as medicine for centuries, especially for the treatment of digestive tract related diseases by practitioners of the Ayurvedic and Unani systems. Viuda-Martos *et al.* (2010) ^[15] discussed critically the potential of pomegranates a functional food because of its nutritious and wholesome properties. Functional food is defined as food that provides beneficial influences on human health, and as a barrier against illnesses. Pomegranate was found to exhibit biological properties such as antioxidant, antitumoral, anti-hepatotoxic, antimicrobial, antiviral, antidiabetic, and anti-inflammatory in different parts of the fruit. The polyphenol and phenolic compounds such as flavonoids, anthocyanins, tannins and ellagic acids are considered as antioxidants which could exhibit remarkable free radical scavenging activity Aviram *et al.* (2010) ^[18], Fazeli *et al.* (2011) ^[16]. The efficacy of pomegranate acting as antiinvasive, antiproliferative and proapoptotic agents in several cancer cell lines *in vitro* and animal models *in vivo* have extensively been studied Lansky and Newman (2007) ^[12]. The presence of polyphenols such as punicalins, ellagic acids and punicalagins could also inhibit the growth of pathogenic bacteria Gil *et al.* (2000) ^[13].

Pomegranate juice contains fructose, it does not elevate the blood sugar level as other fruit juices do. The juice of Pomegranate reduces lesions and the inflammation of blood vessels in heart patients. It is a natural aspirin, which keeps the blood from coagulating and forming blood clots. It even acts as a blood thinner allowing for an unrestricted flow of blood through the body. Its high contents of anti-oxidants

stimulate the white blood cells to neutralize toxins in the body thereby promoting a strong and healthy immune system. Pomegranate juice is used in the treatment of diarrhea and dysentery as it plays a vital role in the secretion of enzymes which aids proper digestion. Pomegranate juice has strong anti-bacterial and antimicrobial properties which help fight viruses and bacteria and boost our immunity system. It significantly reduces microbes that are found in the mouth commonly responsible for cavities and staph infections. Anemia is a condition caused by the deficiency of red blood cells in the body. Since Pomegranate juice contains ample amount of iron it helps in surmounting a deficit of red blood cells in the body if any. Whey beverages are suitable for wide range of consumers from children to the oldest ones. They have not only high nutritive value but also have good therapeutic characteristics. Considering the nutritional, therapeutic and antioxidant properties of pomegranate, it is planned to use the pomegranate juice in the preparation of pomegranate based whey beverage.

Sensory evaluation

Sensory evaluation of pomegranate based whey beverage samples were carried out by a semi-trained panel of judges from the staff of the Department of Animal Husbandry and Dairy Science Post Graduate institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. using 9-point Hedonic scale(Appendix-I) as described by (Hue, 1993) [1].

Statistical Analysis

The Data generated during the course of investigation were analysed using Factorial completely randomized design (FCRD) technique with five replications (Snedecor and Cochran, 1967) [14].

Materials and Methods

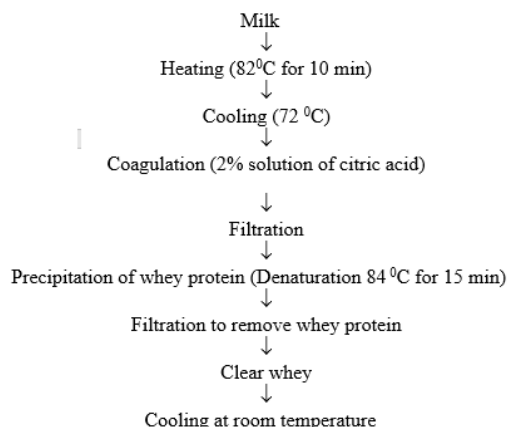
The fresh, clean, composite sample of cow was procured from Research Cum-Development Project (RCDP). R grade citric acid was used to obtain whey preparation available in the Dairy Science laboratory M.P.K.V. Rahuri. Good quality, clean, crystalline, white cane sugar was purchased from local market in Rahuri. Fresh, well riped good quality Pomegranate fruit was procured from fruit market, Rahuri.

Good quality muslin cloth was procured from local market, cleaned and sanitized and used in preparation of Channa to separate/drain out whey.

Methodology

Preparation of whey from cow milk and goat milk

Channa was prepared as per the method given by Sharma *et al.*, (2019) [6] with slight modifications. The cow milk and goat milk was heated in stainless steel vessel at 82 °C, and then cooled to 70 °C. Two per cent citric acid solution is added to milk with continuous stirring resulting in complete coagulation of milk protein (casein). It was then, filtered through two-fold muslin cloth. The resultant liquid whey was collected.



Preparation of pomegranate juice

Pomegranate juice was prepared as per the procedure described by (Ghadge and Jadhav 2015) [2]. Hand press method was employed for extraction of pomegranate juice where arils were separated manually from the fruit. The juice was extracted by crushing the arils followed by pressing through muslin cloth consisting of two layers.

Process optimization

The pomegranate juice was added an attempt was made to prepare pomegranate based whey beverage. the pomegranate juice was added in whey after the draining of whey. The rate of addition of pomegranate juice was decided on the basis of preliminary trials. The treatment were as follows, 12% Pomegranate juice 6% sugar (P1S1), 12% Pomegranate juice 8% sugar (P1S2), 12% Pomegranate juice 10% sugar (P1S3), 14% Pomegranate juice 6% sugar(P2S1), 14% Pomegranate juice 8% sugar(P2S2), 14% Pomegranate juice 10% sugar (P2S3), 16% Pomegranate juice 6% sugar(P3S1), 16%

Pomegranate juice 8% sugar(P3S2), 16% Pomegranate juice 10% sugar (P3S3) The best product was selected on the basis of sensory quality of product, from the result 14% Pomegranate juice 8% sugar was sensorily superior for preparation of pomegranate based whey beverage.

Effect on Colour and appearance score

The colour and appearance provide the first impression of any product, playing a crucial role in determining consumer acceptability. The mean colour and appearance scores of the pomegranate-based whey beverage, influenced by varying levels of pomegranate juice and sugar, are presented in Table 4.7. The colour of the pomegranate-based whey beverage is a combined effect of the inherent pomegranate juice. From Table 4.7, it was observed that the mean sensory scores for colour and appearance of various treatment combinations varied in the range of 6.26 to 8.00, respectively. The colour and appearance score for P2S2 is the highest (8.00), indicating it contains 14% pomegranate juice and 8% sugar in

the whey. This could be attributed to the increased level of pomegranate juice and its dull red colour. The colour and appearance score of the pomegranate-based whey beverage was significantly influenced by the level of pomegranate

juice, which aligns with the findings of Singh *et al.*, (2013) [5]. Simha *et al.*, (2012) [6] also concluded that colour and appearance scores decreased due to the addition of pomegranate peel extract, resulting in a slightly brown colour.

Table 1: Effect of pomegranate juice and sugar on sensory qualities of pomegranate based whey beverage.

Treatments	Sensory attributes			
	Colour and appearance	Flavour	Consistency	Overall acceptability
P ₁ S ₁	7.71±0.1	7.69±0.1	7.81±0.1	7.73±0.1
P ₁ S ₂	7.86±0.1	7.98±0.1	7.90±0.1	7.93±0.1
P ₁ S ₃	7.50±0.05	7.78±0.02	7.60±0.01	7.63±0.03
P ₂ S ₁	7.91±0.06	7.90±0.06	8.10±0.1	7.94±0.02
P ₂ S ₂	8.00±0.01	8.19±0.02	8.16±0.1	8.13±0.01
P ₂ S ₃	7.62±0.05	8.06±0.03	7.88±0.1	7.84±0.02
P ₃ S ₁	6.30±0.04	6.38±0.1	6.50±0.1	6.40±0.06
P ₃ S ₂	6.54±0.02	6.46±0.06	6.60±0.1	6.52±0.03
P ₃ S ₃	6.26±0.01	6.63±0.03	6.20±0.2	6.33±0.01

Mean ±SE of three replications.

Effect on Flavour score

The flavor scores of the pomegranate-based whey beverage, influenced by varying levels of pomegranate juice, are presented in Table. It is observed that the mean scores for flavor across the nine treatments range from 6.38 to 8.19. As the proportion of pomegranate juice increases, there is a significant decrease in the flavor score. The flavor score of the pomegranate-based whey beverage is notably impacted by the level of pomegranate juice. The pomegranate-based whey beverage exhibits the development of a distinct astringent flavor along with a tart taste. The most desirable combination of these components, particularly for the flavor of the pomegranate-based whey beverage, is achieved when the pomegranate juice proportion is at 14 percent and sugar at 8 percent concluded that the chakka whey beverage, with the incorporation of pineapple juice, experienced increased flavor acceptability with an increase in the proportion of pineapple juice up to 20 percent. Sanap (2004) [3] reported that the flavor attributes of a product were significantly influenced by mango pulp level, with the highest points (8.50) scored when mango pulp was included, whereas the product without mango pulp scored the lowest point (6.25).

Effect on consistency score

The consistency scores of the pomegranate-based whey beverage, influenced by varying levels of pomegranate juice, are presented in Table. It is observed that the average consistency score of the pomegranate-based whey beverage ranges from 6.20 to 8.16. Notably, the consistency score of the pomegranate-based whey beverage is found to be non-significantly influenced by the levels of pomegranate juice. Higher levels of pomegranate juice incorporation resulted in a slightly thicker consistency, which was not appealing to the judges. These findings align with who, in their study on nutmeg-based whey beverage, reported that the consistency of the product varied from 7.40 to 8.00. Additionally, Dhadge (2022) [7] observed that the consistency of banana beverage was significantly influenced by the addition of banana extract.

Effect on Overall acceptability score: The overall

acceptability scores of pomegranate-based whey beverage, influenced by different levels of pomegranate juice, are presented in Table. Significant differences were observed among the nine treatments, indicating that all nine treatments differ significantly in terms of sensory parameters. The formulation containing 16 percent pomegranate juice and 10 percent sugar received the minimum score, while the formulation with 14 percent pomegranate juice and 8 percent sugar obtained the maximum score. The interaction effect was found to be non-significant.

The specific behaviour of the treatment combinations regarding overall acceptability can be understood by considering that overall acceptability is the sum of the combination of colour and appearance, consistency, and flavor of the product. There appears to be a significant improvement in all these characteristics, which likely enhanced the judges' preference for the overall acceptability of all nine treatment combinations of the pomegranate-based whey beverage. Furthermore, it can be emphasized that the treatment P₂S₂ (14 percent pomegranate juice and 8 percent sugar) seems to match well in governing the sensory attributes to the most desired optimum level. Hence, it can be inferred that the addition of 14 percent pomegranate juice and 8 percent sugar is the most optimum combination for preparing the best quality pomegranate-based whey beverage.

These results align with the findings of Dhadge (2022) [7], who reported the overall acceptability of banana beverage with lemongrass distillate as 8.00 (T₁), 8.55 (T₂), 8.20 (T₃), and 7.90 (T₄), respectively. Khupse *et al.*, (2019) reported the drumstick (*Moringa oleifera* L.) whey-based beverage had overall acceptability score 7.5 to 8.2 which is in range of overall acceptability score of pomegranate based whey beverage. Dande *et al.* (2018) [11] prepared whey beverage using different levels of grapefruit juice, reporting an overall acceptability ranging from 6.96 to 8.62. developed a nutmeg (*Myristica fragrance*) based whey beverage, reporting an overall acceptability ranging from 7.5 to 8.2. From the discussion of table it is concluded that, pomegranate juice added at 14 percent and sugar added at 8 percent result in the maximum sensory perception

Table 2: ANOVA for Sensory attributes of pomegranate juice and sugar

Sensory properties	Source of variation	d.f.	MSS	F value	CD $p < 0.05$
Colour and appearance	Between pomegranate juice level (H)	2	5.929	1317.7	0.07
	Between sugar level (S)	2	0.260	57.87	0.07
	Interaction (H×S)	4	0.013	2.95	0.12
	Error	18	0.004	----	
Flavour	Between pomegranate juice level (H)	2	6.375	789.6	0.09
	Between sugar level (S)	2	0.116	14.46	0.09
	Interaction (H×S)	4	0.030	3.75	0.15
	Error	18	0.008	---	---
Consistency	Between pomegranate juice level (H)	2	6.731	704.4	0.10
	Between sugar level (S)	2	0.259	27.14	0.10
	Interaction (H×S)	4	0.003	0.96	NS
	Error	18	0.009	----	---
Overall acceptability	Between pomegranate juice level (H)	2	6.407	1090.1	0.08
	Between sugar level (S)	2	0.156	26.69	0.08
	Interaction (H×S)	4	0.002	6.41	NS
	Error	18	0.005	---	----

Means± SE with different superscript indicates the value were statistically significant ($p < 0.05$) within the column

Conclusions

Results of the present study indicated that the resultant product was analyzed for sensory parameters of colour and appearance, flavour, consistency and overall acceptability. From this study it was summarized that pomegranate-based whey beverage prepared by using 14 percent pomegranate juice and 8 percent sugar was most acceptable. The colour and appearance score. The colour and appearance score for P1S1, P1S2, P1S3, P2S1, P2S2, P2S3, P3S1, P3S2 and P3S were 7.71 ± 0.1 , 7.86 ± 0.1 , 7.50 ± 0.05 , 7.91 ± 0.06 , 8.00 ± 0.01 , 7.62 ± 0.05 , 6.30 ± 0.04 , 6.54 ± 0.02 and 6.26 ± 0.01 respectively. The consistency score of pomegranate-based whey beverage as affected by different level of pomegranate juice and sugar was indicated that there was more or less significantly different. The consistency was ranged from 6.20 ± 0.02 to 8.16 ± 0.01 . The lowest score for P1S1 may be because of pomegranate juice was added in lower percentage. The overall acceptability score highest was obtained for pomegranate-based whey beverage prepared from addition of 14 percent pomegranate juice and 8 percent sugar (P2S2).

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