

Utilization of Whey to Increase Properties and Sensory Attributes of Rice

Sushim Chaudhary^{1*}, Dr. B.V. Balasubramanyam²

^{1*} Dairy Technology Division, ICAR-National Dairy Research Institute (Deemed University),
Bangalore, Karnataka-560030, India
sushim07@yahoo.com

² Dairy Technology Division, ICAR-National Dairy Research Institute (Deemed University),
Bangalore, Karnataka-560030, India

Abstract: *Whey is one of the major byproducts of the dairy industry all over the world. A large part of this whey is however, left unutilized and is being disposed off after passing through the effluent treatment system, which constitutes a significant loss of potential nutrients as well as an economic loss to the dairy industry due the several treatment costs that are involved because of the BOD (biological oxygen demand) utilization in the human food chain is thus predominantly favored and since the cereal industry provides an area of tremendous potential, the present investigation was undertaken with an aim to enable the incorporation of whey in the preparation of rice. Addition of paneer whey and cheese whey on the basis of volume i.e. 25%, 50%, 75% and 100% in the preparation rice was studied for sensory analysis, physico-chemical analysis and rheological properties. The results reveals that, sensory evaluation of the rice samples prepared in different whey showed that the overall acceptability of the rice was more for rice made in paneer whey compared to cheese whey. The chemical composition of rice made in paneer whey with 5% TS are as follows: TS ranged from 54.25 to 56.17% and the mean was 55.21%. The mean carbohydrate content ranged from 41.13% while, the protein content was from 3.02 and the fat content was in the range of 0.31-0.39%. The mean value of ash was in the range of 0.56 %. The rheological studies of rice indicate that the rice prepared with incorporation of paneer whey was slightly more firmer, harder but keep less sticky compared to these parameter in control rice samples.*

Keywords: *BOD, human food chain, overall acceptability, physico-chemical analysis, rheological properties, sensory analysis TS.*

1. INTRODUCTION

In India large quantities of whey is produced during the production of channa, paneer and cheese in the dairy sector. It is estimated that about 2% of milk produced in India is converted to Paneer and channa (Aneja et al., 2002). India's annual production is estimated about 200,000 tons of channa and 150,000 tons of Paneer, resulting in the production of about 2 million tons of whey, containing about 130,000 tons of valuable milk nutrients (khamrui and Rajorhia, 1998). In addition, whey is also major byproduct of cheese and casein industry. In recent times, the production of channa and Paneer by the organized dairy sector is increasing gradually resulting in larger quantities of whey for disposal. A large portion of whey coming as byproduct from the organized dairy sector in India is not being utilized and is being disposed after passing through the effluent treatment systems. Because of the high solids content; whey considered as a serious pollutant, requires expensive treatment before disposal. However, some technologies have been developed to utilize whey solids by extracting whey proteins (Werner, 1981), whey soups (Arora and Jha, 2005), whey beverages (Keerthana and Reddy, 2006), coffee drink (Dhaka et al., 2002), cream yoghurt (Kulkarni et al., 1990). However, none of the products listed are of mass consumption type and hence large quantities whey produced in the country by organized sector cannot be absorbed at present. Development of appropriate process for the production of mass consumption products by utilizing whey solids will be in the larger interest of the dairy industry. Since whey is very rich in organic matter and the B.O.D is as high as 30,000-50,000 mg/lit., disposal of untreated whey therefore, possess threat to environment and human and laws are also against this type of disposal.

Rice is known as the grain of life, and is synonymous with food for Asians. More people around the world eat rice as the primary staple of their diet than any other single food. Rice is a nutritious,

affordable source of carbohydrates and is packed with vitamins and minerals. It includes thiamine, riboflavin, niacin, phosphorus, iron, and potassium, and is an excellent source of amino acids. Only a trace of fat is found in either brown or white rice. In addition to being a staple food and an integral part of social rites, rituals and festivals in almost all Asian countries, it has a medicinal value too, which was clearly recognized by the medicine systems of the region centuries ago. Experiments have shown that brown rice and rice bran may help reduce cholesterol in the blood. Brown rice is a good source of fibre and an essential ingredient in a healthy diet.

The present investigation was done to study the influence of incorporation of whey on sensory, physico-chemical and, rheological characteristics of rice, optimise the level of replacement of water by whey in preparation of Cooked Rice.

2. MATERIALS AND METHODS

Cheddar cheese whey and paneer whey obtained from the experimental dairy of National dairy research institute, Bangalore were used in the investigation. At the experimental dairy Meito enzyme in dried form (Meito Sangyo Co., Ltd, Japan) was used as milk clotting agent during cheese production and citric acid (Commercial grade) for coagulating the milk during paneer production. Rice was obtained from the open markets of Bangalore and was cleaned, stored for use in the investigation. Rice was cleaned and cooked using pressure cooker (Up to 3 whistle) and water was replaced by cheese whey (v/v) for five different cooker in the concentration of 100%, 75%, 50%, 25% and 0 % in cooker respectively. Similar process was also done with paneer whey. Sensory of cooked rice was performed on the basis of Color& appearance, flavor, body& texture, overall acceptability on hedonic scale of 1-9.(Patel *et al*, 1993)

Physico-chemical and rheological analysis were done with the help of stander protocol of Puranik, D.B., ICAR, Karnal, India (1997).

3. RESULT AND DISCUSSION

Preparation of Rice with cheese whey

It is a common practice that water is used in the preparation of rice. In the present investigation water was replaced by 25%, 50%, 75%, and 100% (by volume) with cheese whey in the preparation of the rice. The mean sensory scores of the product prepared as compared to control are detailed in table 1 and analysis of variance in table 2.

Table 1: Sensory scores of rice prepared by replacing water with cheese whey

	Color& appearance					Flavour					Body& texture					Overall acceptability			
	cont rol	T1	T2	T3	T4	cont rol	T1	T2	T3	T4	cont rol	T1	T2	T3	T4	cont rol	T1	T2	T3
CW	7.35 ± 0.12	7.11 ± 0.17	7.25 ± 0.14	7.30 ± 0.14	7.30 ± 0.18	7.1± 0.15	7.15 ± 0.14	7.21 ± 0.14	7.28 ± 0.13	7.41 ± 0.16	7.2± 0.11	7.12 ± 0.11	7.23 ± 0.11	7.4± 0.14	7.5± 0.16	7.3± 0.15	7.15± 0.12	7.20 ± 0.12	7.32 ± 0.13
Mean		7.13 ^a	7.24 ^a	7.31 ^a	7.32 ^b		7.19 ^a	7.26 ^a	7.31 ^a	7.47 ^b		7.16 ^a	7.26 ^a	7.51 ^b	7.55 ^b		7.17	7.26 ^a	7.38 ^a
CD	0.13					0.07					0.16					0.06			

- CW= Cheese whey, control= rice in water
- T1=25, T2=50, T3=75, T4=100%
- Mean of 3 trials

The sensory characteristics i.e. color and appearance, flavor, body & texture and over all acceptability scores differed significantly with increase in the level of cheese whey incorporation (Table 1). There is a significant increasing trend in scores of color and appearance, flavor, body & texture and overall acceptability with increase in the level of whey incorporation. There was a clear difference of control rice (rice made in water) and rice made with cheese whey due to the colour of whey which in turn coming into the product. Overall judges sometimes give more score to control followed by rice made in whey. But in average judges likes the rice made in 100% cheese whey.

Table 2 ANOVA for sensory scores of rice prepared by replacing water with cheese and paneer whey in different ratios

Source of variation	DF	Color& appearance		Flavour		Body&texture		Overall acceptability
		MSS	F	MSS	F	MSS	F	MSS
Between treatment	3	0.081	7.180*	0.055	8.231*	0.125	5.108*	0.059
Interaction	2	0.017	1.68	0.003	0.7421	0.004	0.264	0.008
Within	12	0.010		0.005		0.019		0.006
CD		0.13		0.07		0.16		0.06

* Significantly different at P ≤ 0.05

The mean color and appearance, flavor, body & texture and overall acceptability scores in comparison to control are depicted in fig 4.1 to 4.4.

Preparation of rice with paneer whey

Similarly, as previous study, water was replaced here by 25%, 50%, 75%, and 100% (by volume) with paneer whey in the preparation of the rice. The mean sensory scores of the product prepared as compared to control are detailed in table 4.4 and analysis of variance in table 4. The paneer whey was used in the proportions of 4:1 with rice and was prepared as per the flow diagram 3.1.

Table 3: Sensory scores of rice prepared by replacing water with paneer whey

	Color& appearance	Flavour								Body& texture	Overall acceptability								
		control	T1	T2	T3	T4	control	T1	T2		T3	T4	control	T1	T2	T3			
PW	7.2±0.14	7.15±0.20	7.26±0.10	7.32±0.10	7.41±0.14	7.2±0.13	7.16±0.18	7.22±0.11	7.34±0.09	7.58±0.14	7.2±0.09	7.15±0.12	7.29±0.14	7.45±0.17	7.60±0.16	7.2±0.15	7.15±0.1	7.23±0.14	7.35±0.12
Mean		7.13 ^a	7.24 ^a	7.31 ^a	7.32 ^b		7.12 ^a	7.26 ^a	7.31 ^a	7.37 ^b		7.16 ^a	7.26 ^a	7.51 ^b	7.55 ^b		7.17 ^a	7.26 ^a	7.38 ^a
CD	0.13	0.09								0.19	0.07								

- CW= Cheese whey, PW= Paneer whey
- T1=25, T2=50, T3=75, T4=100%
- Mean of 3 trials
- Acidity of conc. whey Ranged between 0.81 to 0.87

Table 4: ANOVA for sensory scores of rice prepared by replacing water with cheese and paneer whey in different ratios

Source of variation	DF	Color& appearance		Flavour		Body&texture		Overall acceptability
		MSS	F	MSS	F	MSS	F	MSS
Between treatments	3	0.186	16.23*	0.091	18.43214*	0.162	7.634*	0.032
Interaction	2	0.016	1.63	0.004	0.74563	0.005	0.237	0.008
Within	12	0.010		0.006		0.021		0.006
CD		0.11		0.10		0.18		0.07

* Significantly different at P ≤ 0.05

The sensory characteristics i.e. color and appearance, flavor, body & texture and over all acceptability scores differed significantly with increase in the level of cheese whey incorporation (Table 3). There is a definite trend and scores of color and appearance, flavor, body & texture and overall acceptability increased with increase in the level of whey incorporation on the basis of volume i.e. with 25%, 50%, 75%, and 100%. There was a clear difference of control (rice made in water) with rice made in paneer whey due to the colour of whey which in turn coming in the product. Hence judges sometimes give more score to control followed by rice made in whey. But in average judges likes the rice made in 100% paneer whey.

The mean colour and appearance, flavor, body & texture and overall acceptability scores in comparison to control are shown in fig 4.5 to 4.8.

Comparison of cheese whey rice and paneer whey rice

A comparative study was done between cheese and paneer whey used for the preparation of the rice. To understand the better acceptability of whey from preparation of rice the mean sensory scores of the product made in cheese whey and paneer whey are presented in table 5 and analysis of variance in table 6.

Table 5: Sensory scores of rice prepared by replacing water with cheese and paneer whey

	Color& appearance				Flavour				Body& texture				Overall acceptability		
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3
CW	7.11± 0.17	7.25± 0.14	7.30± 0.14	7.30± 0.18	7.15± 0.14	7.21 ± 0.14	7.28± 0.13	7.41 ±0.16	7.12± 0.11	7.23± 0.11	7.4± 0.14	7.5± 0.16	7.15± 0.12	7.20± 0.12	7.32± 0.13
PW	7.15± 0.20	7.26± 0.10	7.32± 0.10	7.41± 0.14	7.16± 0.18	7.22 ± 0.18	7.34± 0.19	7.58± 0.14	7.15± 0.12	7.29± 0.14	7.45± 0.17	7.60± 0.16	7.15± 0.1	7.23± 0.14	7.35± 0.12
Mean	7.13 ^a	7.24 ^a	7.31 ^a	7.32 ^b	7.19 ^a	7.26 ^a	7.31 ^a	7.47 ^b	7.16 ^a	7.26 ^a	7.51 ^b	7.55 ^b	7.17	7.26 ^a	7.38 ^a
CD	0.12				0.08				0.17				0.07		

- CW= Cheese whey, PW= Paneer whey
- T1=25, T2=50, T3=75,T4=100%
- Mean of 3 trials

The results revealed that the mean color and appearance of the rice prepared from the paneer whey was significantly ($p \leq 0.05$) higher than the rice prepared from cheese whey. Similarly the flavor score of the rice prepared from paneer whey was significantly higher (Table 6) than the rice prepared by using cheese whey at all proportions of usage. The body & texture and the overall acceptability scores also showed similar trends at all proportions of whey incorporation.

Table 6: ANOVA for sensory scores of rice prepared by replacing water with cheese and paneer whey in different ratios

Source of variation	DF	Color& appearance		Flavour		Body&texture		Overall acceptability
		MSS	F	MSS	F	MSS	F	MSS
Between whey's	1	0.079	8.384*	0.063	9.56434*	0.113	5.278*	0.061
Between treatments	3	0.183	18.03*	0.097	17.85948*	0.163	6.321*	0.029
Interaction	2	0.017	1.74	0.004	0.837921	0.005	0.246	0.008
Within	12	0.010		0.005		0.022		0.006
CD		0.12		0.08		0.17		0.07

* Significantly different at $P \leq 0.05$

Utilization of Whey to Increase Properties and Sensory Attributes of Rice

Since overall acceptability score of the paneer whey incorporated rice was significantly higher than any other score. This also enabled larger utilization of whey, as one of the objectives of the proposed study was to fruitfully utilize the whey solids. Since paneer whey is also available over larger geographical area and also resulted in a product significantly superior to cheese whey based rice, the paneer whey was selected in subsequent studies. A similar observation has been reported earlier by Jaritha and Kulkarni (2009) in the production of soup sticks, Poonam and Ghosh (2007) in the production of bun and pizza base, production of bread (Divya and Jayaraj Rao 2007). The mean colour and appearance, flavor, body & texture and overall acceptability scores are also shown in fig 4.9 to 4.12.

Physicochemical characteristics of rice whey based product

The physicochemical characteristics of rice prepared with whey were analyzed and the results are tabulated in table 7. The TS ranged from 43.25 to 44.17% and the mean was 54.561%. The mean carbohydrate content ranged from 41.13% while, the protein content was from 3.02, while the fat content was in the range of 0.31-0.39%. The mean value of ash was in the range of 0.56 %. The mean pH of product was 6.3 while the water activity ranged from 0.982 to 0.984. Since there is no similar whey based product cited in literature, a comparison could not be established with respect to composition.

Table 7. Physicochemical characteristics of rice prepared in 5% paneer whey

Constituents	Range%	Mean%
Carbohydrates	41.15-44.17	± 1.60
Protein	2.90-3.13	$\pm .21$
Fat	0.31-0.39	0.33 ± 0.02
Ash	0.53-0.77	± 0.07
Moisture	55.1-57.14	56.17 ± 1.15
pH	6.30-6.35	± 0.05
Aw	0.982-0.984	0.982 ± 0.002

Rheological characteristics of rice whey based product

Rheological characteristics of rice prepared by using 5% total solid Paneer whey were carried out and the values are presented in table 8. It is clear from the figure that the product prepared with incorporation of Paneer whey has slightly more firmness, hardness but lower stickiness compared to control sample. The firmness, hardness and stickiness value of rice prepared in 5% Paneer whey is given below in table 8.

Table 8. Rheological characteristics of rice prepared in 5% paneer whey

Sl. No.	Rheological characteristics	Rice in whey (Newton)	Control (Newton)
1	hardness	16.5	17.2
2	stickiness	18.0	13.1
3	firmness	7.1	5.9

4. CONCLUSION

Whey is one of the major byproducts of the dairy industry. In India large quantities of whey is produced during the production of chhana and paneer in the traditional dairy sector. Whey contains almost about 40% of the valuable milk solids with high biological oxygen demand. Hence, whey needs to be treated appropriately for its disposal to avoid environmental pollution. A number of food products are prepared using whey and whey based products but none of these are of mass consumption type. Whey produced as a byproduct in the country during the production of cheese, chhana and paneer is not being utilized by both the organized and unorganized sectors. The sensory

studies of use of cheese whey in rice production revealed that, the sensory scores for all parameters increased with level of replace of water by whey. The use of paneer whey in rice production indicates that the sensory scores of the paneer whey used rice increased with increase in level of the whey in rice. Between the rice prepared by using cheese whey and paneer whey. The incorporation of paneer whey has improved the overall acceptability of the product when compared to control and the rice prepared by using cheese whey. The physicochemical analyzer of paneer whey rice shows that the rice contains of 41.13% carbohydrate, 2.94% protein, 0.33% fat, 0.56% ash, and 51.17% moisture. The water activity was found to be 0.982 and had pH value of 6.31. The rheological studies of rice indicate that the rice prepared with incorporation of paneer whey was slightly more firmer, harder but keep less sticky compared to these parameter in control rice samples.

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AUTHORS' BIOGRAPHY



Sushim Chaudhary, The current dissertation is carried out by me at National Dairy Research Institute during my M.Tech programme in 2008-2010. After wards I joined Amul as Technical officer to pursue professional carrier and till date I am working here.



Dr B.V Balasubramanyam, The current dissertation is carried out under guidance of Shri. Dr. B.V Balasubramanyam. He is currently working Principle scientist at National Dairy research institute in Dairy technology Department. I sincerely thanks to him for his support.