Effect of varying level of dried milk proportion on formulation and reconstitution of *Phirni* mix powder

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Abstract An investigation was undertaken to study the varying proportion of WMP to SMP (25:75, 50:50 and 75:25) for formulation of *Phirni* mix powder (PMP). The sensory quality of experimental *Phirni* increased consistently with the increase in the levels of WMP upto 50:50, thereafter, decreased significantly ($p<0.01$). The maximum sensory scores were obtained with a proportion of 50:50 for all sensory attributes. The textural characteristics were found significant ($p<0.01$) with the increase in the proportion of WMP. Further, the formulation was reconstituted by dispersing the PMP with varying levels of water (50 : 30, 50 : 40 and 50 : 50) and followed by cooked at 85 ± 5 °C for different cooking time (5, 10 and 15 min). The results obtained among the reconstituted water on the sensory and textural attributes were found significant ($p<0.01$). The maximum sensory scores were observed at 10 min cooking time with 50: 40 proportion of PMP to water.

Keywords *Phirni* · Mix powder · Sensory quality · Rheological characteristics

India is the largest milk producer in the world producing 112.5 million tonnes (NDDB 2012), facing globalization trade where the only driver for future growth is value addition. This has been further necessitated by urbanization, change in life styles and shift even in domestic consumers preference for safe and healthy foods. The product ranges that could be particularly important in this context are traditional dairy products (Patange et al. 2006). About 50–55 %

of milk produced is converted by the traditional sector into a variety of Indian milk products (Khan 2006; Jha et al. 2011).

Kheer or *Payasam* has been mentioned in the two great epics Ramayana and Mahabharata of Hindu mythology (Jha and Patel 2002). This *Kheer* or *Payasam* is a cereal based milk product, grouped under the category of milk pudding, which is popular worldwide under various names. It also occupies a place of prominence in the worship of God. *Phirni* have similar product profile as *Kheer* or *Payasam* which contains granular rice instead of rice flour. It is one of the oldest rice puddings in Middle-East or Persia was brought to India by the Moghuls in 14th century (www.answers.com/topic/rice-pudding).

Phirni is heat desiccated cereal based sweetened indigenous dairy product, which is popular within the certain region and community but gaining popularity in all races and all parts of India as well as in Middle-East countries. It is served as dessert. As such, there are no legal standards for *Phirni* in the country and a very few reported literature available. It is conventionally prepared by cooking of rice in the form of paste/flour/suji with buffalo milk along with cane sugar and other additives like cardamom powder, kaju powder, rose water, colour etc. (Mathur et al. 1985). The final texture comes due to the prolong boiling with continuous stirring till it thickens. Finally, it packed in earthen pots/cups, cooled to room temperature and stored at refrigerated temperature (4 °C) before serving.

Its production is limited to unorganized sector of certain region and community; the main constraints to commercialize this product are its poor shelf life, lack of proper packaging and inefficient distribution system. Therefore, there is an urgent need to develop *Phirni* mix powder (PMP) to overcome these constraints to commercialize *Phirni*. Ready mix type of product are gaining popularity worldwide mainly because of the reason that the product can be prepared instantly in short time, easy to store, handling and has guaranteed quality etc. (Rai and Jayaprakasha 2004). Ready-to-eat (RTE)/ready-

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to-serve (RTS)/ready-to-reconstitute (RTR) and ready-mix powder (RMP) are the different types which come under this category. In our country ready mix for *Gulabjamun*, *Payasam*, *Kheer*, *Basundi* etc. have been developed and marketed successfully (Aneja et al. 2002). Milk product and instant mix market in India were around Rs. 250 billion and Rs. 1,000–1,250 million in 1998, respectively (Patil 2002 and Aneja et al. 2002), which shows the significance of traditional dairy products in the national economy. Market of instant mix is growing day to day due to change in life style. Therefore, there is a wide scope for commercialization of such type of product. Keeping in view of importance of this product, an investigation was undertaken with the objective to develop Ready-to- Reconstitute instant mix powder of *Phirni*.

Materials and methods

Raw materials and ingredients

Dried milk Skim milk powder (SMP) of Sagar brand and whole milk powder (WMP) were procured from local market of Mohanpur, Nadia (West Bengal) and Barauni Dairy, Baruni (Bihar), respectively.

Other ingredients Cane sugar, plain rice (basmati) and green cardamom powder were obtained from local market of Mohanpur, Nadia (W.B.).

Preparation of precooked/pre-gelatinized rice powder Precooked rice was prepared as per the method described by Pyke (1984) with some modification. Fresh clean basmati rice was dry heated for 93 °C/15 min in hot air oven. Further, it was soaked in water for 15 min and partially cooked at 80 °C/15 min, washed with clean water, dried and grinded to form precooked/pre-gelatinized rice powder.

Product formulation The product preparation mainly consisted of blending ratio of WMP and SMP, making of pre-gelatinized rice powder and dry blending of these with ground sugar and cardamom powder. Milk powder either WMP or SMP alone, do not meet the desirable sensory and textural qualities of the experimental samples of *Phirni*. Therefore, three proportions of WMP to SMP viz. 25:75, 50:50 and 75:25 were studied with a view to evaluate the best proportion on the basis of sensory attributes in terms of flavour, body and texture, colour and appearance, and overall acceptability along with textural attributes with respect to hardness, softness and adhesiveness for experimental samples of *Phirni*. The formulation is based on the proximal

composition of accepted market samples. The average fat, protein, lactose, sucrose, moisture, total ash and other carbohydrates of market samples were 7.5, 17.0, 23.0, 30.0, 4.5, 4.0 and 14.0 %, respectively. The blends of WMP to SMP at the rate of 50 % were mixed with pre-gelatinized rice powder, ground sugar, and cardamom powder at the rate of 18, 31 and 1 %, respectively.

Preparation of *Phirni* from PMP PMP was dispersed in different proportionate level of water (PMP in g to water in ml viz., 50 : 30, 50 : 40 and 50 : 50) in stainless steel container and then cooked at 85±5 °C for different period of time such as 5, 10 and 15 min with continuous stirring. Further, it was poured in earthen pot or cup, cooled and stored at refrigerated temperature (4 °C).

Analytical techniques The PMP was analyzed for fat, moisture and ash (ISI 1981), lactose and sucrose (Perry and Doan 1950). Total nitrogen content in the product was estimated by Micro-Kjeldahl method as per AOAC (1995) and considered conversion factor 6.25 for converting percent of nitrogen to protein as suggested by James (1995). The other carbohydrates were estimated by the difference.

Rheological studies A texture analyzer model number TAHDi (Stable Micro System, U.K.) fitted with a 250 kg load cell were used for analysis of different rheological parameters of *Phirni* prepared from PMP. A cross head pre test speed of 1.0 mm/s, test speed of 1.0 mm/s, post test speed 1.0 mm/s and 10 mm distance for penetration was fixed up. A cylindrical probe of 5 mm diameter (P5) was used for textural study. The texture analyzer having separate software (Texture Expert) for its operation was run under windows environment. A microprocessor has been coupled with texture analyzer to run the texture expert programme. In the Texture Expert, result file has been programmed to calculate the texture profile analysis (TPA) data from the measurements. The hardness, softness and adhesiveness were directly calculated from force–time curve.

Sensory evaluation of experimental *Phirni* The experimental samples of *Phirni* prepared by developed mix were evaluated in terms of flavor, body and texture, colour and appearance, and overall acceptability on a 9-point hedonic scale through sensory panelist consisting of 6 trained judges.

Statistical analysis The data were statistically analyzed using the SYSTAT Software (version 6.01). In all experiments, data were subjected to analysis of variance (ANOVA), using randomized block design and standard deviation (SD) as described by Snedecor and Cochran (1968).

Results and discussion

Effect of varying proportion of dried milk (WMP: SMP) on formulation of PMP

Sensory characteristics The results pertaining to the effect of varying proportion of WMP to SMP on the sensory characteristics of *Phirni* prepared from PMP is presented on Table 1. The variation in the sensory scores viz. colour and appearance, flavour, body and texture, and overall acceptability obtained for the experimental *Phirni* prepared using all the three proportion of WMP to SMP were found significant ($p<0.01$). It is evident from the result that sensory scores for all attributes increased successively with the increase in the levels of WMP to SMP till 50 : 50, thereafter, the score decreased significantly ($p<0.01$). The maximum scores were attained at a proportion of 50: 50 of WMP to SMP for all sensory attributes. Above this level of WMP, the body and texture was soft and developed undesired rich flavor in *Phirni* causing to less score. WMP usually impart a rich flavour in *Phirni*, when the level crosses its threshold level. Hence, blending of WMP with SMP minimizes the intensity of undesired richness and softness of *Phirni*. No work has been reported so far for the standardization of *Phirni* and PMP which make it difficult to compare the results. However, comparable sensory scores of the experimental samples of *Phirni* were found with market samples of *Phirni*.

Rheological characteristics Rheological studies in terms of hardness, softness and adhesiveness measure the gel strength which shows the body and texture of prepared sample of *Phirni*. The effect of varying proportion of WMP to SMP on rheological characteristics was assessed with a view to evaluate the effect of varying proportions of WMP and SMP on the gel strength as well as body and texture of prepared sample of *Phirni*. The result relating to the rheological attributes such as

hardness, softness, adhesiveness of the prepared sample of *Phirni* using dried milk having three proportion of WMP to SMP viz. 25: 75, 50: 50 and 75: 25 is shown in Fig. 1. It is evident (Fig. 1) that the values for hardness showed a decreasing trend from 52.68 ± 4.39 g to 12.59 ± 4.43 g with the increase in the level of WMP from 25 to 75, while adhesiveness showed a increasing trend from -33.94 ± 4.03 gs to -89.28 ± 4.03 gs with the increase in fat level. Softness values also increased with the increase in WMP level. This variation may be attributed to the fat that hardness has inverse relationship with fat, while softness and adhesiveness has direct correlation with the fat. Further, in any product increase in fat level soften the product. This correlation therefore, supports the findings of this investigation.

The statistically analysis of the data shows that the variation in the values of hardness, softness and adhesiveness with the increase in the proportion of WMP were found significant ($p<0.01$). This may be attributed to the softening characteristics of the fat incorporated through the increasing proportion of WMP in this blend used as dried milk.

Effect of varying proportion of PMP and water for reconstitution

Sensory characteristics The pre-gelatinized starch essentially retains the properties of the starch used for pre-gelatinization except for being swellable in cold water (Balachandran 1985; Dias et al. 1997). For proper swelling of the pre-gelatinized rice, attaining proper gel strength and shortening the cooking time, the appropriate amount of water is to be added for reconstitution of PMP. The result pertaining to effect of proportion of PMP to water for reconstitution on sensory characteristics of *Phirni* is presented in Table 2. It is evident from result, that the variation amongst the three proportion of PMP to water viz., 50 : 30, 50 : 40 and 50 : 50 (g : ml) on the sensory attributes were found significant ($p<0.01$). The maximum

Table 1 Effect of varying proportion of dried milk on sensory quality of *Phirni*

Sensory characteristics	Proportion of dried milk (WMP : SMP)			MSS
	25 : 75	50 : 50	75 : 25	
Colour and appearance	6.83 ± 0.15	7.17 ± 0.18	6.20 ± 0.32	2.054**
Flavour	6.87 ± 0.17	7.17 ± 0.16	5.79 ± 0.46	2.826**
Body and texture	6.81 ± 0.26	7.56 ± 0.27	6.05 ± 0.23	1.725**
Overall acceptability	6.63 ± 0.23	7.63 ± 0.26	5.92 ± 0.21	2.324**

Each value of mean $\pm$ SD of five replicates ($n=3$)

MSS Mean sum of squares

** Significant at 1 % level ($P<0.01$)

Fig. 1 Effect of varying proportion of dried milk on rheological characteristics of *Phirni*

scores was attained with 50 : 40 (g : ml) level of PMP to water for all sensory attributes of prepared sample of *Phirni* employing heating at 85 ± 5 °C for 10 min for cooking. The higher proportion showed more time required for attaining desired consistency. The result obtained during rheological studies indicated that improper gel strength pertaining to softer body confirms the finding of this investigation. This may be due to the varying degree of gel strength with varying level of water level for reconstitution of PMP. The results obtained during this investigation were also supported by rheological studies, hence PMP (g) to water (ml) ratio 50:40 was considered for reconstitution of PMP.

Rheological characteristics Rheological characteristics such as hardness, softness, adhesiveness were measured by texture analyzer with a view to assess the effect of varying proportion of PMP (g) with water (ml) to give adequate and desired gel strength so as setting of prepared sample of *Phirni* on cooling.

The results pertaining to the effect of varying proportion of PMP (g) to water (ml) viz. 50: 40, 50: 30 and 50: 50 on the rheological characteristics such as hardness, softness and

adhesiveness is shown in Fig. 2. It is evident (Fig. 2) that with the increase in water level, the hardness and adhesiveness decreased, while softness followed an increasing trend.

The maximum values for hardness and adhesiveness were 51.52 ± 5.90 g and -77.08 ± 2.66 gs, respectively with 50: 30 proportion of PMP to water whereas, the minimum values were 19.29 ± 6.55 g and -32.21 ± 3.39 , respectively at 50:50 ratio of PMP to water. This may be due to increase in the level of water as more water is bounded. Thus, there is decrease in the gel strength. The result observed in sensory evaluation also indicated that body and texture characteristics scored highest sensory scores for 50: 40 proportions of PMP to water. The observed values for hardness, softness and adhesiveness with 50 : 40 proportion of PMP to water were 34.81 ± 6.20 g, 344.28 ± 37.16 gs and -55.85 ± 3.08 gs, respectively. The statistical analysis of data indicate the variation amongst the three proportion of PMP to water (g: ml) viz. 50: 30, 50: 40 and 50: 50 were found significant ($p < 0.01$) (Table 2) which may be attributed to the binding of more water with the increase in level of water.

Thus, it may be concluded that 50 : 40 proportion of PMP and water (g : ml) showed desirable body and texture in the experimental samples of *Phirni* after cooking and cooling also adjusted by rheological measurement. This was also supported by the results obtained during sensory evaluation. Hence, 50: 40 proportion of PMP to water (g: ml) was considered and recommended for reconstitution of PMP.

Effect of varying cooking time on reconstitution of PMP

Sensory characteristics Starch gelatinizes at certain temperature and imparts gel strength, giving adequate body and texture. Gaman and Sherrington (1997) reported that starch gelatinize at 85 °C. Hence, during this investigation PMP reconstituted at 85 ± 5 °C for three varying cooking time (5, 10 and 15 min) for proper gelatinization of starch. The results pertaining to the effect of cooking time on sensory scores of

Table 2 Effect of varying proportion of PMP to water and cooking time for reconstitution on sensory quality of experimental *Phirni*

Reconstitution parameters	Colour and appearance	Flavour	Body and texture	Overall acceptability
Proportion of PMP(g) to water(ml)				
50:30	5.78 ± 0.14	5.89 ± 0.12	6.13 ± 0.15	5.72 ± 0.22
50:40	7.67 ± 0.12	7.59 ± 0.27	7.66 ± 0.21	7.62 ± 0.26
50:50	6.92 ± 0.16	6.71 ± 0.14	6.60 ± 0.26	6.80 ± 0.10
MSS	2.718**	2.151**	1.825**	2.738**
Cooking time (min)				
5	6.91 ± 0.22	6.91 ± 0.21	7.07 ± 0.16	6.87 ± 0.22
10	7.77 ± 0.11	7.78 ± 0.13	7.80 ± 0.05	7.80 ± 0.16
15	5.93 ± 0.22	5.87 ± 0.17	6.11 ± 0.19	5.81 ± 0.16
MSS	2.524**	2.762**	2.103**	2.954**

Each value of mean $\pm$ SD of five replicates ($n=3$)

MSS Mean sum of squares

**Significant at 1 % level ($P < 0.01$)

Fig. 2 Effect of varying proportion of PMP to water for reconstitution of PMP on rheological characteristics of *Phirni*

prepared samples of *Phirni* from PMP is presented in Table 2. The results obtained in this investigation indicated that the variation amongst sensory scores for variations in cooking time were found significant ($p < 0.01$). The maximum sensory scores were attained on cooking at 85 ± 5 °C/10 min for all attributes. The sensory attributes scored lower values on cooking at 85 ± 5 °C/5 and 15 min. Cooking for 5 min resulted in improper gel strength leading to inability for setting of *Phirni* on cooling, while heating for 15 min showed a hard body.

Rheological characteristics The effect of three varying levels of cooking time at 85 ± 5 °C for 5, 10 and 15 min were attempted during this investigation with a view to assess the best period of cooking at 85 ± 5 °C to obtaining proper body and texture in the experimental samples of *Phirni*.

The results relating to rheological characteristics like hardness, softness and adhesiveness is presented in Fig. 3. The results obtained during this investigation showed that with the increase in the period of cooking at 85 ± 5 °C, there was an increase in the hardness and adhesiveness values, while softness followed a decreasing trend. The highest values of hardness and adhesiveness were obtained at 85 ± 5 °C for 15 min being 70.99 ± 4.39 g and -65.71 ± 3.05 gs, respectively, while softness showed the highest values at 85 °C for 5 min being 436.26 ± 6.70 gs. At 85 ± 5 °C for 15 min, the body and texture

Fig. 3 Effect of different cooking time of reconstituted PMP on rheological characteristics of *Phirni*

of the prepared samples of *Phirni* was too firm, making the product unacceptable. Further, the sensory scores supported the cooking period at 85 ± 5 °C for 10 min in terms of maximum scores obtained of body and texture. Hence considered for the cooking of reconstituted PMP using 50: 40 proportion of PMP to water (g: ml) at 85 ± 5 °C for 10 min. The statistical analysis of data indicates that the variation amongst the period of cooking at 85 ± 5 °C i.e. 5, 10 and 15 min were found significant ($p < 0.01$) (Table 2), which may be attributed to the increasing gel strength with the increasing period of heating.

Proximate composition of PMP

Moisture in powders is an important property, which affects the shelf life and flow properties. The moisture content of the PMP was 5.5 %, which was higher than WMP, but comparable to SMP as reported by De 2008. The fat content of the PMP (6.8 %) was less than that of WMP (26 %), but higher than SMP (1.5 %). The protein content of the PMP was less than that reported for WMP (Miocinovic and Ostojic 1983) and the ash content was appreciably lower than that reported by Tseng (1978) for WMP (5.65 %). Total carbohydrates in the PMP were higher as compared with both WMP and SMP on account of the added sugar and rice flour.

Conclusion

Three proportion of WMP to SMP (25 : 75, 50 : 50 and 75 : 25) were studied for formulation of PMP, the highest scores was observed with proportion of WMP to SMP (50 : 50) with respect to sensory attributes like colour (7.17 ± 0.18), flavour (7.17 ± 0.16), body and texture (7.56 ± 0.27), and overall acceptability (7.63 ± 0.26). In addition to that, 50: 40 proportion of PMP to water for reconstitution showed most acceptable product on the basis of sensory and rheological attributes. Further, three levels of cooking time at 85 ± 5 °C for 5, 10 and 15 min were also studied and it was found that 5 min cooking showed inadequate and weak gel, while 15 min cooking showed very firm body. The highest sensory scores and desirable rheological properties were found with 10 min cooking. Therefore, on the basis of sensory and rheological characteristics the best combination for manufacture of PMP were WMP to SMP (50:50), pre-gelatinized rice powder, ground sugar and cardamom powder at the rate of 50, 18, 31 and 1 %, respectively.

References

Aneja RP, Mathur BN, Chandan RC, Banerjee AK (2002) Technology of Indian milk products. A Dairy India Publication, New Delhi

- AOAC (1995) Official methods of analysis, 16th edn. Association of Official Analytical Chemists, Washington
- Balachandran R (1985) Milk gel and milk puddings. *Indian Dairyman* 37:125–127
- De S (2008) Outlines of dairy technology, 16th edn. Oxford University Press, New Delhi
- Dias FF, Tekchandani HK, Mehta D (1997) Modified starches and their use by food industry. *Indian Food Ind* 16:33–39
- Gaman PM, Sherrington KB (1997) The science of food, 1st edn. Pergamon Press, London, p 69
- <http://www.answers.com/topic/rice-pudding> Accessed 17.05.2010.
- ISI (1981) IS:SP-18 (Part XI) ISI handbooks of food analysis (Dairy products). Indian Standards Institution, Manak Bhavan
- James CS (1995) Analytical chemistry of foods, 5th edn. Blackie Academic and Professional, p 41
- Jha A, Patel AA (2002) Instant Kheer mix – a value added convenience product for Indian Dairy Industry. *Indian Dairyman* 54:55–59
- Jha A, Patel AA, Gopal TKS, Nagaraj Rao RC (2011) Development of process for manufacture of long-life dairy dessert kheer and its physicochemical properties. *Int J Dairy Technol* 64:591–597
- Khan AQ (2006) Milk and milk products: an entrepreneurial approach. All India dairy business directory-2006, p 115–117
- Mathur ON, Bhattacharya DC, Roy NK (1985) Phirni: an Indian sweet dish. *Indian Dairyman* 37:575–578
- Miocinovic KK, Ostojic CS (1983) Chemical and physical aspects of spray dried powders. *Acta Aliment Pol* 15:321–326
- NDDDB (2012) National statistics: production in India. <http://www.nddb.org/statistics/milkproduction.html>. Accessed 17/01/2012
- Patange DD, Singh RRB, Patel AA, Patil GR (2006) Consumer acceptance of ready-to-reconstitute Basundi mix. *Indian J Dairy Sci* 59:151–154
- Patil GR (2002) Present status of traditional dairy products. *Indian Dairyman* 54:35–46
- Perry NA, Doan FJ (1950) A picric acid method for the simultaneous determination of lactose and sucrose in dairy products. *J Dairy Sci* 33:176–185
- Pyke M (1984) Food science and technology, 4th edn. John Murray Publication, London, p 43
- Rai KV, Jayaprakash HM (2004) Formulation of instant Gulabjamun mix from the admixture of spray dried skim milk powder and whey protein concentrate. *J Food Sci Technol* 41:244–247
- Snedecor GW, Cochran WG (1968) Statistical methods, 6th edn. Oxford and IBH Pub. Co., New Delhi, p 258
- Tseng G (1978) Dry milk products: a comparison of conventional and instant whole milk powder. *NZ J Dairy Sci Technol* 13:133–135