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Optimization of level of incorporation of soy milk to prepare soy milk paneer

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Abstract
The present study was conducted to optimise the level of incorporation of soy milk for the preparation of 'soy milk blend paneer'. In the experiment, paneer was prepared from whole milk (control) and a blend of whole milk and soy milk (prepared from soaked soyabean and water (1:3.5)) *viz.* T1 (whole milk: soy milk: 2:1) and T2 (whole milk: soy milk: 1:1). The treatments were analysed for various physico-chemical qualities and sensory evaluation. Based on sensory evaluation, the acceptability of paneer was improved with the incorporation of soy milk at T1 level (whole milk: soy milk: 1:1). The yield, pH, and moisture content also increased significantly with the addition of soy milk to whole milk. The protein, fat, and ash content were comparable between the treatments. Thus, the addition of soy milk to whole milk can be effectively carried out to improve the economics of paneer and add variety to products without compensating for its taste.

Keywords: Soy milk paneer, protein, cow milk, coagulum

Introduction
India is the leading milk producer in the world, with an estimated production of 221.1 million tonnes in 2021-22 and a per capita availability of milk of 444 g/day (NDDB, 2022) [7]. Milk is a good source of high-quality protein, fat, carbohydrates, vitamins, and minerals. Milk coagulum can be used as a base for different dairy products like paneer, rasogolla, chhana, etc. and can be processed into shelf-stable products with a high nutritive profile, providing opportunity for value addition (Lalawmpuii *et al*. 2018) [3].

Soybean is often called the 'golden miracle bean' and is the world's foremost provider of protein and oil. As it contains about 20% oil and 40% quality protein, it is used for the preparation of health foods, feed sources, and industrial products (Jain and Mhatre, 2009) [1]. Soy protein is a complete protein as it contains all of the indispensable amino acids required by the body in the correct proportions and is the only complete plant-based protein relied upon by those maintaining a vegetarian lifestyle (Thakur *et al*. 2016) [4].

Paneer is an important indigenous product and a highly nutritious food prepared from cow or buffalo milk or a combination of both by acid coagulation using suitable acid (Kumar *et al.* 2014) [8]. Although milk is a good source of high-quality protein and other nutrients, it may not be accessible to low-income groups because of the price factor; therefore, there is a need to develop technology for the production of low-cost paneer (Raja *et al.* 2014) [6]. Utilisation of lower-cost protein sources such as soybeans for the preparation of low-cost paneer will not only help reduce the production cost but will also add variety to the product. In view of the above facts, the present study was conducted to develop and evaluate the quality of soy milk paneer.

Materials and Methods
Milk, additives and chemicals
Pasteurised milk (a combination of cow and buffalo milk) for pursuing this study was procured from the Dairy Technology Section of the Indian Veterinary Research Institute, Izatnagar, Bareilly (U.P.). Soybean was procured from the local market in Bareilly. All the chemicals used were of analytical grade and obtained from standard firms. (Qualigens, Merck and Hi Media).

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For the preparation of soya milk

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100 g is weigh and soaked for 12 hrs.
↓
1 glass of soaked soybean+ 3.5 glass of water (1:3.5)
(1 glass of soaked soybean = 194g and 1 glass of water=273 g)
↓
Grind in a mixer grinder for 2 mins. till all the soybeans are grounded
↓
Filter with a muslin cloth and collect the filtrate
↓
Residues are discarded
↓
Filtrate is ready for preparation of paneer
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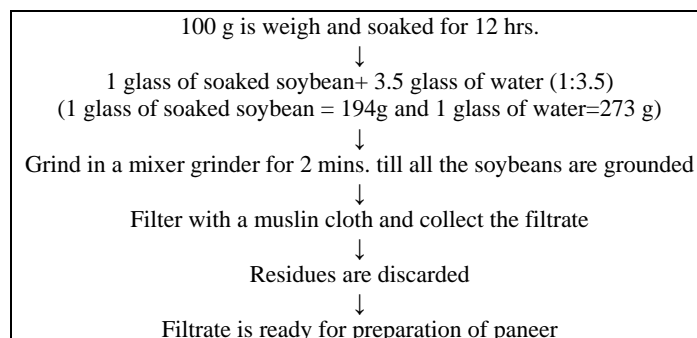
Fig 1: Flow chart for the preparation of soy milk

Preparation of Paneer
Paneer was prepared following the procedure of Bhattacharya (1971) [2], with slight modifications as per the requirements of the experiment. Milk with 4.5% fat was used in the experiment, and the processing protocol is shown in Fig. 2. and the groups with different treatments are shown in Table No. 1.
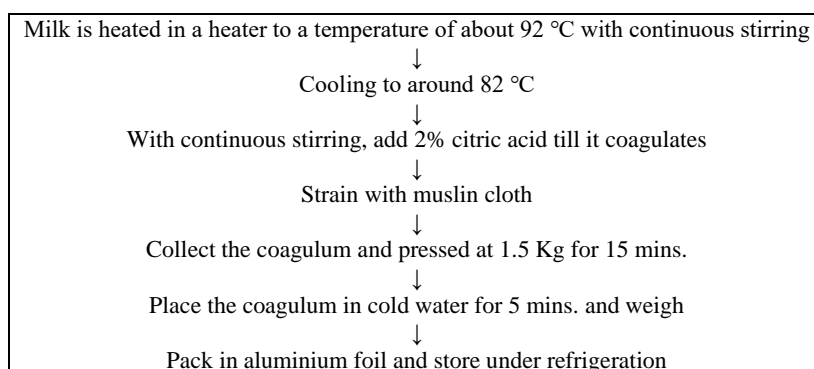
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Milk is heated in a heater to a temperature of about 92 ℃ with continuous stirring
↓
Cooling to around 82 ℃
↓
With continuous stirring, add 2% citric acid till it coagulates
↓
Strain with muslin cloth
↓
Collect the coagulum and pressed at 1.5 Kg for 15 mins.
↓
Place the coagulum in cold water for 5 mins. and weigh
↓
Pack in aluminium foil and store under refrigeration
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Fig 2: Flow chart for the preparation of paneer

Table 1: Different combination of soy milk incorporation for the preparation of Paneer

Groups	Treatments
Control	Whole milk
T1	Whole milk and soy milk (2:1)
T2	Whole milk and soy milk (1:1)

After the preparation of paneer, it was stored in aluminium foil under refrigeration and analysed for its various physico-chemical analyses and sensory evaluations.

Physico-chemical analysis
The pH of the sample was measured using a digital pH metre as per Trout *et al*. 1992 [9]. The proximate composition of the sample, such as moisture, protein, fat, crude fibre and ash content, was determined by standard methods as per AOAC (2005) [10]. Moisture and ash content were determined using a hot air oven and muffle furnace, respectively. Fat content was extracted from a moisture-free sample in a Soxhlet extraction apparatus. The protein content of pork nuggets was estimated using the Kjeldahl method.

Sensory evaluation
The sensory evaluation was conducted by a semi-trained panel consisting of scientists and postgraduate students of the Division of Livestock Products Technology, IVRI, Izatnagar, using an eight-point descriptive scale (Keeton, 1983) [11], where 8 is excellent and 1 is extremely poor. The panellists were briefed on the nature of the experiments without disclosing the identity of the samples and were requested to rate them on an eight-point descriptive scale on the sensory evaluation pro forma for different attributes. Sensory evaluation was organised around 2.30-4.00 p.m. every time. Plain, potable water was provided to rinse the mouth in between the samples.

Statistical analysis
The experiments were repeated three times, and samples for each parameter were drawn in duplicate for analysis (n=6), whereas seven panellists analysed the samples for sensory attributes (n=21). The data were analysed using SPSS software (Version 20.0 for Windows; IBM SPSS Inc., Chicago, 111, USA) and expressed as the mean with standard error. A two-way analysis of variance (ANOVA) was done by comparing the means using Duncan's multiple range test at the 95% confidence level (Steel and Torrie, 1981) [12].

Result and Discussion
Physico-chemical analysis
The incorporation of soy milk in whole milk resulted in a significant ($p<0.05$) increase in yield, which increased as the incorporation level increased. The pH followed an increasing pattern with the increase in the level of soy milk and increased significantly ($p<0.05$) with soy milk incorporation. This is in contrast to the findings reported by Thakur *et al.* (2016) [4], who reported a decrease in moisture percentage with soy milk incorporation. The addition of soy milk also increased the moisture content of the paneer.

The protein content of the paneer improved significantly ($p<0.05$) with the addition of soy milk and this may be attributed to the high protein content of soybeans (Jain and Mahtre, 2009) [1]. The fat content of all the paneer, irrespective of the treatments, does not follow a definite pattern but is significantly ($p<0.05$) lower in the T2 group.

Thakur *et al.* (2016) [4] also reported an increase in protein content and a decrease in fat content with the incorporation of soy milk. A significant reduction ($p<0.05$) in the ash content was observed in the soy milk blend paneer, and a decrease in ash content with an increase in the level of soy milk incorporation was observed.

Table 2: Physico-chemical characteristics of Paneer (Mean± S.E)*

Parameters	Control	T1	T2
Yield (g)	62.6 ± 0.09^a	76.95 ± 0.04^b	77.1 ± 0.07^c
pH	5.7 ± 0.06^a	5.73 ± 0.21^b	5.76 ± 0.08^c
Moisture (%)	56.87 ± 0.04^a	62.9 ± 0.05^b	65.6 ± 0.05^c
Protein(g)	20.78 ± -0.12^a	21.88 ± 0.89^b	22.97 ± 0.11^c
Fat (%)	40.27 ± 0.05^b	40.7 ± 0.45^c	38.83 ± 0.06^a
Ash (%)	$1.425\pm y0.07^c$	1.068 ± 0.06^b	0.96 ± 0.09^a

n=6 for each treatment; *Mean ± S.E. with different superscripts row wise (small letter) and differ significantly (p<0.05).
Control: Whole milk paneer; T1: soya milk and whole milk (1:1); T2: soya milk and whole milk (1:2).

Sensory evaluation
Sensory evaluation of the control paneer and soy milk blend paneer (T1 and T2) was performed, and parameters such as appearance, colour, flavour, body and texture, binding, juiciness, aftertaste, and overall acceptability were evaluated. A close perusal of Table 3 showed that the appearance and colour of all the paneer were comparable, and no appreciable changes were observed with the incorporation of soy milk.
The flavour score of the treatment groups (T1 and T1) was significantly ($p<0.05$) lower than the control and this may be due to the lower level of milk fat in the treatment group, as fat contributes significantly to the flavour of milk. The binding

and juiciness also improved with the incorporation of soy milk.
An aftertaste score was lowered significantly ($p<0.05$) with the incorporation of soy milk, and this may be due to the typical beany flavour of soy milk as well as the lower fat content in the treatment groups (Tripathi *et al.* 2018) [5]. The overall acceptability of the control was higher than that of the treatment groups incorporating soy milk. However, the overall acceptability of the T1 and T2 were also scored $7.08\pm.38^b$ and $7.05\pm.47^a$ respectively, indicating that all the products were highly acceptable.

Table 3: Sensory evaluation of Paneer (Mean± S.E.)*

Samples	Appearance/Colour	Flavour	Body & Texture	Binding	Juiciness	Aftertaste	Overall Acceptability
Control	7.17 ± 0.22^b	7.2 ± 0.20^c	7.22 ± 0.27^c	6.98 ± 0.31^b	$7.06\pm.43^a$	$7.07\pm.48^c$	$7.22\pm.23^c$
T1	7.07 ± 0.32^a	6.93 ± 0.41^a	7.15 ± 0.41^b	7.16 ± 0.48^c	$7.17\pm.29^c$	$6.95\pm.44^a$	$7.08\pm.38^b$
T2	7.18 ± 0.25^b	7.09 ± 0.47^b	7.0 ± 0.5^a	6.97 ± 0.48^a	$7.1\pm.19^b$	$6.97\pm.45^b$	$7.05\pm.47^a$

n=21 for each treatment; *Mean ± S.E. with different superscripts row wise (small letter) and differ significantly ($p<0.05$).
Control: Whole milk paneer; T1: soya milk and whole milk (1:1); T2: soya milk and whole milk (1:2).

Conclusion
In this study, it was observed that the incorporation of soy milk into whole milk for the preparation of paneer improved the yield by around 10%. An increase in yield and pH was observed with soy milk incorporation. The physico-chemical analysis reveals no major differences with soy milk incorporation and the sensory evaluation also depicts that all the products were highly acceptable. It can be concluded that soy milk should be incorporated with whole milk to prepare paneer to make a variety of products at a cheaper price while at the same time having a composition that is close to control.

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