Studies on Physico-Chemical Properties of Vermicelli Prepared by Using Skim Milk Powder

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Abstract
In the present study vermicelli was prepared by using skim milk powder at three different treatment levels of 0, 5, 10 and 15%, respectively. It was observed that as the level of skim milk powder increased, moisture content of vermicelli increased from 7.21 to 6.90 %, fat content decreased from 0.53 to 0.61%, protein content increased from 9.70 to 14.63%; ash content increased from 0.55 to 1.44%; crude fiber content decreased from 2.06 to 1.67%; carbohydrate content decreased from 79.95 to 74.68% for treatments T1, T2, T3 and T4, respectively. The experimental results revealed that with increase in SMP, cooked vermicelli weight increased from 353.10 to 274.95 g/25 g, cooking solid loss increased from 2.18 to 5.10% and swelling index decreased from 3.67 to 3.36 under the selected experimental ranges. Therefore, it was concluded that use of 10 % skim milk powder with 90 % refined wheat flour for preparation of vermicelli is acceptable, cheaper and adaptable as far as processing technology is concerned.

Keywords: Refined wheat flour, Skim milk powder, Vermicelli and Physico-chemical parameters.

1. Introduction
Now a day consumers’ have become more health and nutrition conscious as a result of which they are constantly looking for novel food products where in local produce (cereals, grains and legumes) are incorporated (Thomas et al., 2014). This consumer demand has provided a drive for both researchers and food manufactures to explore and formulate new food products (With improved taste, texture and appearance) with new technology and traditional knowledge. Due to the effort of many researchers, the pasta products were blended with protein rich ingredients (Indra and Kowsalya, 2014).

The vermicelli is a traditionally popular ready-to-eat (RTE) instant food product. It falls under the category of extruded product and is made from wheat flour. Vermicelli is widely consumed throughout the world and its global consumption is second only to bread. It is the fast growing sector of the food industry due to its convenience, easy to cook, low cost and have a relatively long shelf life (Hatcher, 2001; Gulia et al., 2014). It is usually cooked in boiling water and sometimes with cooking oil or salt. It is often pan-fried or deep-fried and served with an accompanying sauce or in a soup. It is rich in protein and liked by people from all walks of life irrespective age. There are different ways of consuming them as well as different recipes available in different countries.

In India, particularly Maharashtra, vermicelli is prepared from refined wheat flour in summer season and used throughout the year as instant dish as traditional product locally called shewai (Ronge et al., 2017). Vermicelli is usually made from soft wheat flour by a process of sheeting and cutting or by a process of extrusion using die with round holes diameter of different range i.e. 1 to 4 mm to get strands followed by cutting. The quality of any food product depends particularly on the base material used for its preparation. The refined wheat flour has moisture content of 13.29%, fat 1.78%, protein 13%, ash 1.32%, crude fiber 0.62% and carbohydrate 70%. As the fiber content of refined wheat flour is less, a number of studies related to vermicelli qualities have investigated the potential of adding fiber sources to vermicelli. Various researchers have tried to improve the nutrient and fiber content of noodles or vermicelli by incorporating or substituting wheat flour with defatted soy flour, pulse flour, banana powder, millet flour, okra malted flour or milk powder etc. However, much less information is available regarding use of milk solids.
particularskimming milk powder (SMP) for its preparation except Baskaran et al. (2011). Convenience foods haveplayed a vital role in the life being since antiquity as they reduce varying steps involved in the preparationup to cooking. Therefore, in this study an attempt was made to prepare vermicelli using SMP to improveits nutritional content as well as textural properties and was compared with its traditional form called shewai.

2. Materials and Methods
The research work was work carried out in the department of Animal Husbandry and Dairy Science, College of Agriculture, Latur (M.S.), India.

2.1 Materials
The different ingredients used for preparation of vermicelli were refined wheat flour, skim milk powder, good quality clean crystalline sugar and common salt and were procured from local market of Latur (M.S.), India. The refined wheat flour used for the product was Samrat suji of Prakash Agro Industry Ltd., Pune and SMP manufactured by Milk and Milk products Pvt. Ltd, Phaltan. The vermicelli was prepared by using extruder machine, Jhowtala Ghosh Dutta Para, Kolkata (W.B.). The prepared vermicelli was spread on perforated trays and subsequently sun dried. The sundried vermicelli was packed in Low Density Polythene pouches (100 gauges).

2.2 Preparation of Vermicelli from Wheat Flour and SMP
The vermicelli was prepared as per the procedure given by Baskaran et al. (2011) with slight modifications as shown in the following flow chart (Fig 1). Treatments detail:

T1 = Vermicelli prepared with 100 % of refined wheat flour
T2 = 95 % of refined wheat flour + 5 % SMP
T3 = 90 % of refined wheat flour + 10 % SMP
T4 = 85 % of refined wheat flour + 15 % SMP

2.3 Physico-Chemical Analysis of Vermicelli
Chemical analysis of prepared vermicelli was carried out to evaluate the nutritional adequacy of the prepared product. The fat and crude fiber contents of the product were determined by standard procedure as described in A.O.A.C. (1990). The moisture, protein, ash and carbohydrate contents were determined as per the method described in IS: SP (Part XI) (1981). The moisture content was determined using hot air oven maintained at 105 °C for 24 hours. Protein was estimated using micro-Kjeldahl distillation method. The crude fiber content was estimated using acid and alkaline digestion method. Fat dissolved in solvent (ether) was estimated out by vaporizing the solvent. Ash content was determined by igniting product in furnace at 550°C (dull red) until light gray ash results. The total carbohydrates were calculated after determining the percentage of moisture, protein, fat, ash and crude fiber.

Carbohydrate (percent by weight) = 100 - (A+B+C+D+E)

Where,
A = Percentage by weight of moisture
B = Percentage by weight of protein
C = Percentage by weight of fat
D = Percentage by weight of ash
E = Percentage by weight of crude fiber

2.3.1 Cooking of Vermicelli
The prepared vermicelli sample of 25 g was cooked in 250 ml of boiling water until center core disappeared and cooked product was obtained (Fig 2). Consistency was checked manually by pressing it in thumb and index finger. The vermicelli was subsequently drain using stainless sieve.

2.3.2 Cooking Weight
Vermicelli was cooked and cooking weight was determined by weighing the drained vermicelli and reported in g/25 g.

2.3.3 Solid Gruel Loss
Solid loss was determined as per the method described by Mestres et al. (1988) with slight modification by cooking vermicelli samples in boiling water for 20 minutes as described. After cooking, the cooked material was strained out and the whole filtrate was transferred quantitatively in to a pre-weighed petri dish. It was evaporated over a water bath followed by drying in a hot air oven maintained at 105 ± 2°C for 1 hour. The petri dish was again weighed with the dried solids. Then, the solid loss was calculated

Solid gruel loss = \[
\frac{W_1 - W_2}{W} \times 100
\]

Where,
W - Initial weight of vermicelli taken for cooking in g.
W1 - Weight of empty Petri dish, g
W2 - Weight of Petri dish with dried solids after evaporation, g
Common salt was added at 0.5% of total mixtures during each treatment.

![Figure 1: Flow chart for preparation of vermicelli with skim milk powder](image1)

![Figure 2: Cooking quality of prepared Vermicelli samples.](image2)

### Tables 1: Physico-chemical analysis of *vermicelli*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Ash (%)</th>
<th>Carbohydrate (%)</th>
<th>Crude fiber (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>79.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.06&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T2</td>
<td>7.17&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.55&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>11.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td>77.61&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.93&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T3</td>
<td>7.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.58&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>13.53&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.29&lt;sup&gt;c&lt;/sup&gt;</td>
<td>75.60&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.79&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>T4</td>
<td>6.90&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.61&lt;sup&gt;d&lt;/sup&gt;</td>
<td>14.63&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.44&lt;sup&gt;d&lt;/sup&gt;</td>
<td>74.68&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.67&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*The column wise values superscripted by similar letters are at par with each other at 5% level significance

### 2.3.4 Swelling Index

Swelling index of *vermicelli* was determined by method proposed by (Mestres *et al.*, 1988). A known weight (5 g) of vermicelli was cooked in a glass beaker with 20 times its quantity of boiling water (100 ml) for 10 minutes over a water bath maintained at 100 °C. After cooking, the water was strained out and the cooked *vermicelli* was dried to remove surface moisture using filter paper and the cooked sample was weighed.
From the initial and final weights of vermicelli, swelling index was calculated as:

\[ \text{Swelling Index} = \frac{W_f - W_i}{W_i} \times 100 \]

Where,
- \( W_i \) = Weight of cooked product before cooking in gm.
- \( W_f \) = Weight of cooked product after cooking in gm.

2.4 Statistical Analysis
The result obtained in relation to chemical composition and cooking quality of vermicelli were subjected to statistical analysis using completely randomized block design (CRBD) as per the method given by Panse and Sukhatme (1985).

3. Results and Discussion
3.1 Physico-Chemical Analysis of Vermicelli
The finished product was subjected to the proximate analysis viz fat, protein, ash, carbohydrate, and crude fiber. The results obtained in relation to these parameters are presented in Table 1.

3.1.1 Moisture
Moisture percentage in vermicelli prepared from different levels of SMP is presented in Table 1. It is observed that the average moisture content in treatments T1, T2, T3 and T4 were 7.21, 7.17, 7.0 and 6.90%, respectively. The treatment T1 and T2 treatments and also T3 and T4 were at par with each other. Treatments T3 and T4 showed the significant difference for moisture contents in vermicelli with control and T2. The maximum moisture content was observed in control treatment T1, while the minimum moisture content was observed in treatment T4 prepared by using SMP. It is observed that with the increase in SMP levels there was reduction in the moisture contents of vermicelli (Fig 3). The present results are in agreement with the trends for pasta prepared using semolina, chick pea flour whereas a decreasing trend of moisture percentage was observed for defatted soy flour by Bashir et al. (2012). Kulkarni et al. (2012) developed nutrient rich noodle by supplementation with malted ragi flour and reported a moisture content of 7.12% while Mogra and Midha (2011) reported moisture content range of 6.9 to 7.7% in vermicelli.

3.1.2 Fat
The above Table 1 indicates that the average fat contents of vermicelli were 0.53, 0.55, 0.58 and 0.61 for treatment T1, T2, T3 and T4, respectively. All the treatments were significantly differed from each other. It was also observed that as the quantity of skim milk powder in the vermicelli increased, fat content of the vermicelli was increased. The maximum fat content was observed in T4 and minimum in T1. The highest fat content in T4 might be due to higher fat content in SMP. The successive treatments were found at par with each other at 5% level of significance (i.e. T1-T2, T2-T3 and T3-T4) but alternate treatments were significantly different with each other (i.e. T1-T3 and T2-T4). The treatment T4 was significantly different. It means the skim milk powder at the rate of 5% not differ so much.

The present results are in agreement with Baskaran et al. (2011) who analyzed chemical attributes of noodles supplemented with skim milk powder and reported the fat content of 0.55, 0.56, 0.56, 0.54%. Bashir et al. (2012) prepared pasta using semolina, chick pea flour and defatted soy flour and reported fat percentage ranges between 0.57 to 0.77. However, the fat percent observed by Doke et al. (1990) in vermicelli as 0.19% was lower than that observed in present investigation.

3.1.3 Protein
From the Table 1 it can be observed that the average protein content of the vermicelli was 9.70, 11.89, 13.53 and 14.63% for treatments T1, T2, T3 and T34, respectively. The per cent protein content in all the treatments was significantly differed from each other. The highest protein content was recorded for treatment T4 i.e. 14.68%. The lowest protein content was recorded for treatment T1 i.e. 9.70%. This might be due to the incorporation of skim milk powder to vermicelli. As skim milk powder in the product increased, the protein content in finished product was also increased. The present results obtained were in agreement with Doke et al. (1990) who carried out an extensive experiment on vermicelli and reported the maximum protein content as 13.76%. Sood et al. (2009) evaluated quality of wheat fruited pasta products made from blends of jamun and papaya pulp and reported the protein content as 12.58, 13.09, and 13.00 %, respectively for the experimental range. Similar increasing trends were observed by Mogra and Midha (2011) for vermicelli using whole wheat flour, malted wheat flour and in combination with gram dhal, spinach and sago flour and Eyidemir and Hyata (2009) for apricot kernel flour added noodle formulation.

3.1.4 Ash
The average ash content of the vermicelli was found to be 0.55, 0.84, 1.29 and 1.44 for treatments T1, T2, T3 and T4, respectively (Table 1). The highest ash
Table 2: Effect of SMP on cooking weight of vermicelli

<table>
<thead>
<tr>
<th>Treatments/Replications</th>
<th>Cooking weight (gm) Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R-I</td>
</tr>
<tr>
<td>T₁</td>
<td>355.00</td>
</tr>
<tr>
<td>T₂</td>
<td>338.00</td>
</tr>
<tr>
<td>T₃</td>
<td>277.50</td>
</tr>
<tr>
<td>T₄</td>
<td>280.00</td>
</tr>
</tbody>
</table>

SE = ± 1.49  
CD at 5% = 4.53

Values with superscripts are significantly different at P<0.05

Table 3: Effect of SMP on solid gruel loss of vermicelli

<table>
<thead>
<tr>
<th>Treatments/Replications</th>
<th>Solid gruel loss (%) Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R-I</td>
</tr>
<tr>
<td>T₁</td>
<td>2.15</td>
</tr>
<tr>
<td>T₂</td>
<td>3.24</td>
</tr>
<tr>
<td>T₃</td>
<td>4.40</td>
</tr>
<tr>
<td>T₄</td>
<td>5.00</td>
</tr>
</tbody>
</table>

SE = ± 0.0259  
CD at 5% = 0.0798

Values with superscripts are significantly different at P<0.05

Table 4: Effect of SMP on swelling index of vermicelli

<table>
<thead>
<tr>
<th>Treatments/Replications</th>
<th>Swelling index Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R-I</td>
</tr>
<tr>
<td>T₁</td>
<td>3.64</td>
</tr>
<tr>
<td>T₂</td>
<td>3.48</td>
</tr>
<tr>
<td>T₃</td>
<td>3.36</td>
</tr>
<tr>
<td>T₄</td>
<td>3.30</td>
</tr>
</tbody>
</table>

SE= ± 0.0291  
CD at 5% = 0.0896

Values with superscripts are significantly different at P<0.05

content was recorded for treatment T4 (1.44%). The lowest ash content was recorded for control treatment T1 (0.55%). The increase in ash content might be observed due to the calcium content of SMP.

Above findings were in agreement with Baskaran et al. (2011) who analyzed chemical attributes of noodles supplemented with 5, 7.5 and 10% SMP and with those reported by Bashir et al. (2012) for pasta, Mogra and Midha (2011) for vermicelli and Eyidemir and Hyata (2009) for apricot flour added noodles.
3.1.5 Carbohydrates

From Table 1 it can be observed that the average carbohydrate contents were between 74.68 to 79.95% within the experimental range. The least value of carbohydrate content (79.95 %) was recorded for treatment T1. It was observed that the carbohydrate content of the finished product decreased from T1 to T4 with corresponding increase in SMP (Fig 3).

These findings were in agreement with those reported by Doke et al. (1990) for vermicelli (71.97%); Baskaran et al. (2011) for noodles supplemented with SMP and Mogra and Midha (2011) for vermicelli (75.2 to 69.8%).

3.1.6 Crude Fibre

The crude fiber content in the vermicelli was found to be 2.06, 1.93, 1.79, and 1.67 % for treatments T1, T2, T3 and T4, respectively (Table 1). It was also observed that as the level of SMP increased, the crude fiber content of product also decreased which may be due to the low fiber content in skim milk powder as compared to wheat flour.

The present findings were in agreement with crude fiber content of noodles supplemented with skim milk powder (Baskaran et al., 2011) in which the author reported the decreasing trend of crude fiber content with increase in SMP levels. Kulkarni et al. (2012) found 0.3 % crude fiber content in nutrient rich noodles supplemented with malted ragi flour.

3.2 Cooking Quality of Vermicelli

3.2.1 Cooking Weight

The cooking weights of vermicelli prepared in different treatments combinations were determined. The results obtained are presented in (Table 2).

It was observed that the mean cooking weight of vermicelli treatments were 353.10, 336.66, 280.52 and 274.95 gm for treatments T1, T2, T3 and T4, respectively, which was reduced in every progressive treatment due to the use of SMP. The treatments were significantly different from each other at 5% level of significance. The percent cooking weight losses were observed as 7.36, 20.68 and 22.38% in treatments T2, T3 and T4, respectively. This might due to cooking loss of SMP used for preparation of vermicelli. The nutrient losses were observed more in last two treatments which may be due to the solubility of skim milk powder in water, cooking temperature and time. To conserve nutritive losses in higher treatments there is need to optimize the cooking condition of vermicelli and use of proper binder/stabilizer for vermicelli preparation in future. Similar trend of decrease in weight of the cooked sample was reported by Agrawal et al. (2013) for vermicelli prepared from minor millets and by Mamatha and Mushtari (2013) for diabetic vermicelli prepared from Amruthballi and Madhunasini. In contrast to present findings Prabhasankar et al. (2007) found increasing weight of vermicelli prepared from durum wheat flour, whey protein concentrate (WPC) and observed that with increase in whey protein concentrate (WPC) from 0-10%, cooked vermicelli weight increased from 82.5-88 g/25 g and cooking loss increased from 6.0-8.4%.

3.2.2 Solid Gruel Loss

The solid gruel loss of vermicelli samples were determined by considering the initial weight of vermicelli before cooking and solid gruel loss obtained in filtrate after removing the moisture from it and the results obtained are presented in (Table 3). It was observed that average solid gruel loss of cooked vermicelli in T1, T2, T3 and T4 were 2.18, 3.20, 4.35 and 5.10 %, respectively. The treatments were significantly different at 5% significance level. The maximum solid gruel loss was observed in treatment T4 followed by treatment T3, T2, and minimum solid gruel loss was observed in treatment T1 (control) obtained from wheat flour.

The results obtained in present experiments were in agreement with those observed by Karpagavalli and Amutha (2015) for cereal pulse blended spaghetti with cooking losses in the range of 8.16-7.57 % and by Sudha et al. (2014) for kodo millets based pasta with gruel losses from 2.98 to 9.84%.

3.2.3 Swelling Index

The swelling indices of vermicelli under different treatment combinations were determined. The results obtained are presented in Table 4.

The swelling indices of the vermicelli for different treatments were in the range of 3.67 - 3.36%. The treatments were significantly different with each other. The maximum swelling index of 3.67% was observed for treatment T1 (control) and minimum swelling index of 3.36% was observed for T4 prepared by addition of 15% SMP. It indicated that as level of SMP increased, there was decrease in swelling index of the cooked vermicelli. This might be due to the leaching of whey solid during cooking. The present results were in agreement with the findings of Sudha et al. (2014) for kodo millets pasta and higher than the findings of Priyenka et al. (2015) who reported lower swelling indices for non-wheat vermicelli in the range of 1.8% to 2.99% and 2.95 to 3.85 g/g for kodo millet based pasta (Sudha et al., 2004).

4. Conclusion

From present investigation it can be concluded that the skim milk powder can be very well utilized for...
preparation of palatable, nutritional and low cost vermicelli by using 10% of SMP in 90% refined wheat flour on weight basis. Overall there was increase in protein, ash and fat content and decrease in moisture, carbohydrate and crude fiber content of vermicelli with corresponding increase in levels of SMP. There were cooking losses and decrease in swelling index due to addition of SMP.

References