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Optimization and Quality Evaluation of Oats (Avena sativa) Flour Incorporated Paneer

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Abstract

Efforts were initiated to prepare a carbohydrate, calcium and fibre rich paneer by addition of oat flour (Avena sativa). Six samples' formulations were prepare including control paneer, (100% milk curd). The different formulations of (oats flour: milk curd) in the ratio as: sample (1:99), sample (1.5:98.5), sample (2:98), sample (2.5:97.5) and sample (3:97) to access the quality and acceptability of paneer. The experiment was designed by central composite mixture design and the obtained data was analyzed statistically by Genstat Discovery Edition 3 (DE3), for Analysis of Variance (ANOVA) at 5% level of significance version 12.1. The oats flour and milk curd for the development of value-added product, and evaluate proximate and sensory characteristics of product.

The sensory evaluation revealed sample (1:99) was found to be best by comparing sensory score of overall acceptance given by the panelists and functional components. Crude protein, crude fat, total ash and carbohydrate of control product were found to be 41.43%, 49.7%, 4.39% and 4.44% whereas for best product the results were 40.54%, 48.97%, 4.39% and 5.92% respectively. The calcium content of best paneer and control paneer were found to be 467.08 mg/100 g and 399.12 mg/100 g respectively. The fiber contents were zero and 0.156% in control and best product sample (1:99) respectively. Therefore, it was concluded that the incorporation of oats flour for the formulation of value-added paneer will be helpful for developing value-added dairy products for the developing countries.

Article Info

1. Introduction

Paneer is a South Asian variety of soft cheese obtained by acid and heat coagulation of milk. It is a non-fermentative, non-renneted, non-melting and un-ripened type of cheese. Paneer is popular throughout South Asia, used in raw form or in preparation of several varieties of culinary dishes and snacks. The production of paneer is now spreading throughout the world. The ability of paneer to be deep fried is one feature that has led to its wider acceptance and a favorite for making snacks, pakoras or fried paneer chunks. Paneer is a rich source of animal protein available at a comparatively lower cost and forms an important source of animal protein for vegetarians. Over and above its high protein content and digestibility, the biological value of protein in paneer is in the range of 80 to 86. In addition, paneer is a valuable source of fat, vitamins and minerals like calcium and phosphorus (Khan and Pal, 2011).

According to Prevention of Food Adulteration rules, paneer means a product obtained from cow's or buffalo's milk or a combination thereof by precipitation with sour milk, lactic acid, or citric acid. It shall not contain more than 70% moisture and the fat content shall not be less than 50% of the dry matter. Good quality paneer is characterized by a typical acidic flavor with slightly sweet taste, a firm cohesive and spongy body, and a closely-knit, smooth texture (Sachdeva et al., 2009)

Oats belongs to the family of poaceae and is commonly known as Avena Sativa. Oats are generally regarded as a minor cereal crop when considered in terms of grain produced annually, or areas sown for

production. Traditionally, most of the crop has been used as animal feed. Oats has been recognized as a healthful and nutritious cereal containing high concentration of soluble fiber and dense nutrients (Ahmed et al., 2014). Oats for food use are first dehulled, because hulls are not suitable for humans without processing although readily digested by ruminants. However, properly processed makes it useful fiber ingredient for the food industry. Oat has recently attracted its research and commercial attention mainly due to its high nutritional value. Oats is a good source of antioxidant, vitamin E (tocols), phytic acid, phenolic acid and avenanthramides (Ahmed et al., 2014)

Oats is well accepted in human nutrition and it is an excellent source of carbohydrate, minerals, arabinoxylans and cellulose. It contains relatively high levels of protein, lipids (unsaturated fatty acids), vitamins, antioxidants, phenolic compounds and minerals. The main part of the physiological effects of oats soluble fiber is due to the elevation of viscosity (Ahmed et al., 2014). Thus, it is of key importance to ensure a sufficient dose and a good extractability, and minimize the effect of factors reducing the molecular weight of β -glucan. β-glucan has been shown to have effects on the glycemic, insulin, and cholesterol responses to foods. Oats are good sources for functional ingredients like calcium, fiber, β - glucan, with studies clearly demonstrating their potential health benefits. Irrespective of nutritionally rich cereal, it has physiological benefits like positive effect on reducing hyperglycemia, hyperinsulinemia, hyper-cholesterolemia and several other benefits. Paneer lacks fiber so due to different health benefits of oats flour, incorporation of oats flour as a source of fiber was carried out in the present study. Calcium present in milk and oats flour helps in building the cross linkages during the formation of curd and thus helps in increasing the recovery of milk solids, yield and improves body and texture and overall acceptability scores of paneers (Sachdeva et al., 1985)

2. Materials and Method

2.1 Collection of raw materials

The standard DDC (Dairy Development Corporation, Nepal) milk of 5% fat, 8% SNF and rolled oats named 'kellogg's' was bought from local market of Itahari, Eastern part of Nepal.

2.2 Experimental design

The recipe formulation for the oats incorporated paneer shown in Table 1.

Table 1: **Experimental design for preparation of oats flour incorporated paneer**

Ingredients	A	B	C	D	E
Curd (%)	99	98.5	98	97.5	97
Oats (%)	1	1.5	2	2.5	3

The design of experiment was given five different formulations and coding of sample A, B, C, D, and E to each recipe. The sample A, B, C, D and E were curd: oats ratio 99:1, 98.5:1.5, 98:2, 97.5:2.5 and 97:3 in percentage respectively.

2.3 Preparation of oats flour

Oats flakes were grinded with the help of grinder. The oats were powdered in the laboratory, pulverized to a fineness that 90% of the powder passed through 400 μ sieve. The flour obtained was shield in a plastic container and stored at ambient condition for further processing (Bhosale *et al.*, 2020)

2.4 Standardization of milk fat

In order to obtain the product with uniform composition and maximum yield, milk needs to be standardized (5% fat, 8% SNF) .by mass balance method. Standardization also enables the manufacturer to confirm to the standards requirements for paneer (Bhosale *et al.*, 2020).

2.4.1 Heating of milk

The standardized milk was heated at 80 °C to 90 °C for pasteurization at a constant medium flame with continuous stirring. In order to maximize the total solids recovery, it is desirable to heat the milk to 90 °C without holding (Sachdeva *et al.*, 1985).

2.4.2 Cooling and coagulation

The heated milk was allowed to cool to 70 °C for coagulation. 1% citric acid solution was used for coagulation. Acid solution was poured slowly with constant light stirring till greenish whey separated out. It was allowed to stand as such for five minutes for curd settlement and complete curd-whey separation (Smitha *et al.*, 2014).

2.4.3 Whey drainage

After coagulation of milk, the curd was allowed to settle down for 5 min without stirring. During this period the temperature should not be allowed to drop below 63 °C (Smitha *et al.*, 2014). Thereafter, the curd along with the whey was transferred in a hoop lined with muslin cloth to remove the whey.

2.4.4 Mixing

The weight of the curd before pressing was measured and oats flour (1%, 1.5%, 2%, 2.5% and 3% of the weight of curd) was added and mixed properly.

2.4.5 Pressing

Pressing was done in a wooden mould of dimension 4"×4"×4" with a pressure of 2kg/cm^2 for 15 min as per (Vishweshwaraiah, 1987). Pressing was done for complete whey expulsion and to get the final desired shape of the product. After pressing, the pressed curd was weighed for the yield of paneer cut into desired dimensions and then dipped in previously prepared clean chilled water at 3-4 ºC for 1-2 h to arrest the growth of microorganisms. Then, it was vacuum packed in LDPE plastic and refrigerated.

2.5 Compositional Analysis

Protein (Kjeldahl, N× 6.25), fat (solvent extraction and gurber methods), moisture (hot air oven), ash (dry ashing) calcium, and crude fiber of cassava flour, oats flour and best product were determined by AOAC (2000) methods. The carbohydrate content was calculated by difference method.

2.6 Sensory evaluation

The sensory analysis for overall quality was carried out by ten semi-trained panelists. The parameters for sensory evaluation were texture, colour, taste, flavour and overall acceptability. Sensory evaluation was performed according to the 9 Point Hedonic Scale as in appendix A.

2.7 Statistical analysis

All the data obtained in this work were analyzed by the statistical program known as GenStat program which was developed by Lawes Agricultural Trust (1955). The results of the sensory evaluation were statistically studied using software GenStat Release version 12.1. The results of sensory analysis were subjected to two-way ANOVA and LSD tests at 5% level of significance among formulations were made. Actually, the judgements of panelists were on the

basis of their likes and dislikes but not on the basis of physiochemical composition of the product. The samples were coded as A, B, C, D and E. The ANOVA (no blocking) and LSD results of the sensory analysis of all five paneer samples.

3. Results and Discussion

The study was carried out to optimize the oats flour incorporated paneer. The fresh whole milk was analysed for proximate composition. All samples were prepared and stored aseptically. The prepared paneer was cut into cubes of dimension 2cm×2cm×2cm (±0.5cm) and subjected to sensory evaluation. The best sample was selected from the sensory evaluation and analysed data statically.

3.1 Composition of milk

The composition of milk was used for panner preparation was shown in table 2.

Table 2: Composition of milk used for paneer preparation.

Parameters	Results (% ,wb)
Moisture	86.4(1)
Fat	5.01(0.05)
Protein	3.98(0.02)
Lactose	3.95(0.02)
Ash	0.75(0.1)

The values in the table are means of the triplicate sample and the figures in the parenthesis the standard deviations.

The results of the milk composition from the above data are in accordance with the findings of (Gantner *et al.*, 2015) and (Robinson, 1996). The composition of result obtained has little variation over the composition of milk. (Dahal, 2009). This variation in composition of milk may be due to the species, nutritional aspect of animal, stage of lactation and feeding of animals. The variation may also be due to different processing standard and specification of dairies.

3.2 Composition of oats flour

The composition of result obtained has variation over the composition of oats analyzed by (Zhao et al., 2014). This variation in composition of oats due to the varieties of oats and processing standards. The composition of oats was farming in tropical region
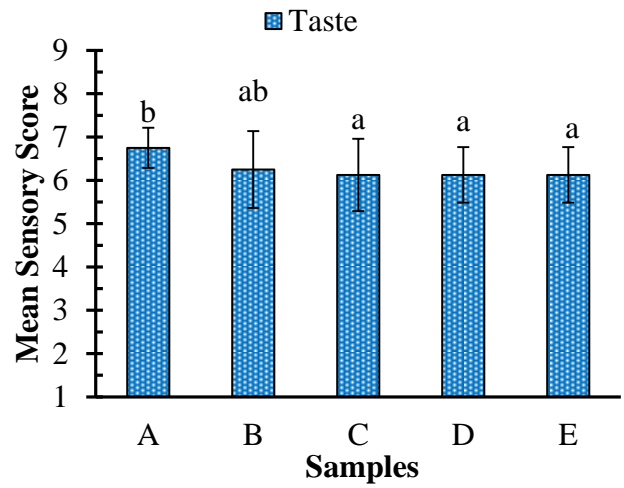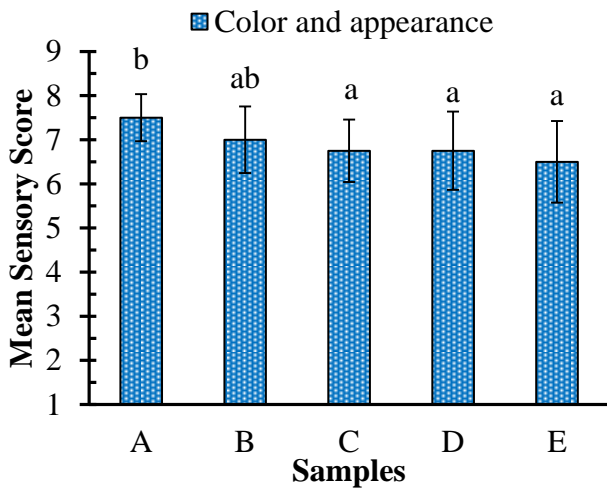
have lower calcium and fiber content than found in cold

Figure 1 (Left): Mean sensory scores for color and appearance of paneer of different formulations.

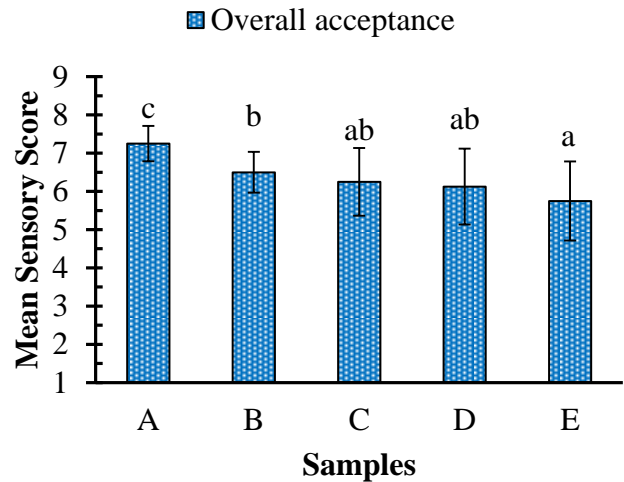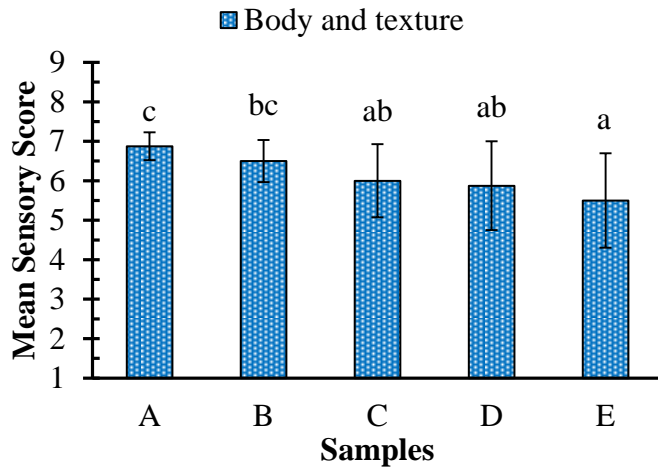**Figure 2 (Right):** Mean sensory scores for taste of paneer of different formulations

Figure 3 (Left): Mean sensory scores for body and texture of paneer of different formulations.

Figure 4 (Right): Mean sensory scores for overall acceptance of paneer of different formulations.

Table 3: Composition of oats flour used for paneer preparation

Constituents	Results (%, wb)
Moisture	10.5(0.26)
Fat	9.13(0.11)
Carbohydrate	60.72(0.47)
Protein	11.67(0.11)
Crude fiber	5.853(0.03)
Ash	2.12(0.02)
Calcium(mg/100g)	44.33(2.081)

The values in the table are means of the triplicate sample and the figures in the parenthesis are the standard deviations.

climate. The compositions of oats flour used in panner shown in table 3.

3.3 Effect of oats flour incorporation on sensory attributes of paneer

3.3.1 Color

The mean sensory scores for color were found to be 7.500, 7.000, 6.750, 6.750 and 6.500 for the paneer formulation A, B, C, D, and E respectively. Statistical analysis showed that partial substitution of curd with oats flour had significant effect ($p<0.05$) on color and appearance of the different paneer formulations. The

product A was not significantly different to sample B but was significantly different to others, which is shown graphically in Fig 1. The product A and B got highest score than products C, D and E.

The color and appearance of the sample changed significantly with the inclusion of oats flour. The color affects the appearance as well. There was no significant difference between product A and B due to small proportion of oats flour. As the amount of oats flour increases, off- white color as well as doughy appearance of paneer also increases because oats flour was creamy brown color than milk curd, which is similar to the finding (Narayanan et al., 2016).

3.3.2 Taste

The mean sensory scores for taste of paneer were found to be 6.750, 6.250, 6.125, 6.125 and 6.125 for the paneer formulation A, B, C, D and E respectively. Statistical analysis showed that partial substitution of curd with oats flour had significant effect ($p < 0.05$) on the taste and flavor of the different paneer formulations. The product A was not significantly different to sample B but was significantly different to others, which is shown graphically in Fig 2. The product A and B got highest score than products C, D and E. The taste attribute showed no significant difference between any of the oats flour incorporated paneer. Oats flour incorporated paneer got low mean value than control paneer due to subtle sweet, toasty and nutty flavor of oats. Taste is one of the important attributes for consumer acceptance. Hence, this designer paneer could be used as a means of improved fiber content in the otherwise fiber deficient paneer (Narayanan et al., 2016).

3.3.3 Body and Texture

The mean sensory scores for body and texture were found to be 6.875, 6.500, 6.000, 5.875 and 5.500 for the paneer formulation A, B, C, D and E respectively. Statistical analysis showed that partial substitution of curd with oats flour had significant effect ($p < 0.05$) on the body and texture of the different paneer formulations. Here among the prepared paneer samples, sample A was found to be superior to all followed by sample B. Samples C, D and E were lacking good texture.

The maximum mean value for body and texture was observed in sample A than for other oats flour

incorporated paneer. This decrease may be due to increased crude fiber content of oats flour in the curd and oats flour blend. The results obtained are in accordance with the findings of (Narayanan et al., 2016) found that as the concentration of oats flour increases the product becomes pastier in consistency.

3.3.4 Overall acceptance

The mean sensory scores for overall acceptance were found to be 7.250, 6.500, 6.250, 6.125 and 5.700 for the paneer formulation A, B, C, D, and E respectively. Statistical analysis showed that partial substitution of curd with oats flour had significant effect ($p < 0.05$) on the overall acceptance of the different paneer formulations. The product A got the highest score among different formulation of oats flour incorporated paneer. So, sample A was selected as best product and further physio-chemical analysis was done. The product A got highest score followed by sample B than other samples. Fig 4. shows the mean sensory scores for overall acceptance of paneer. Sample E has the lowest overall acceptability due to decrease in color, taste, body and texture. At 1% oats flour (sample A) level of incorporation, paneer had highest score for entire sensory attributes than other formulations. As the proportion of the oats flour increases, off-white color and doughy appearance of paneer increases. The pastiness texture of oats flour incorporated paneer increases as the amount of oats flour increases (Narayanan *et al.*, 2016)

3.4 Proximate composition of product

Table 4: Chemical analysis of paneer (%db)

Parameters	Control sample	Best sample(A)
Protein (%)	41.43±0.2	40.54±0.19
Fat (%)	49.7±0.04	48.97±0.05
Crude fiber (%)	-	0.156±0.005
Total ash content (%)	4.39±0.02	4.39±0.13
Total carbohydrate (%)	4.44±0.19	5.92±0.02
Calcium content (mg/100g)	399.12±4.5	467.08±1.15

Values in the table are arithmetic mean of triplicate samples. Figure in the parentheses indicates standard deviation.

Thus, from statistical sensory analysis, the best

product was found to be sample A paneer containing 1% oats flour and 99% curd. The proximate composition of sample A and control paneer is presented in (Table 4.) The chemical analysis of the best product and control sample was done. According to a study by(Masud *et al.*, 1992), fat, protein, lactose and ash content of paneer made from buffalo milk was 57.8%, 32.18%, 4.66% and 5.34% respectively which closely matches with my findings. Similarly, another study by (Desale *et al.*, 2009) found the average fat content in the range of 33.97% -38.21% and average protein content of 38.21% from wide variety of samples. The results of this study were comparable to the findings of (Desale *et al.,* 2009). The results of table 4. are also in close accordance to the findings of (Kumar and Farthing, 1995) where fat content of 51.58% and protein content of 38.44% of paneer was observed.

4. Conclusion

Incorporation of 1% oats flour used to improve nutritional quality especially fibre and carbohydrate however, overall acceptability decreased in comparison with control sample. Therefore, the value-added product with a ratio milk curd and oats flour 99:1(A) found to be accepted by sensory panelists but color and flavour of oats flour added paneer was not accepted by panelists in comparison with control sample . The nutritional quality of sample A reported good fibre, calcium, fat and carbohydrate content along with the overall acceptability. Therefore, with a certain outcome the attempt to formulate a value-added product with fibre has been successfully attained. Further studies are recommended on shelf life and effect of packaging on the value-added product.

5. Acknowledgments

6. Conflicts of Interest

The authors declare that they have no competing interests.

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