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Development of pasta products using cereal pulse blends

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ABSTRACT

Pasta products are one of the most ancient food forms in which wheat has been consumed. A study was conducted to prepare spaghetti with the incorporation of cereal pulse blends and to find out its keeping quality when packed in polyethylene bags of 200 gauge (P_1) and 400 gauge (P_2) stored at room temperature. The cooking qualities, nutritional and organoleptic characteristics of spaghetti were assessed during the storage period of 180 days. The cooking time, cooked volume, cooked weight and water absorption except cooking loss of spaghetti was decreased with the addition of cereal pulse blends. A gradual increase in moisture, protein, fat, crude fibre and ash content was observed in cereal pulse blended spaghetti. T_1 and T_2 samples was found to be the best treatments which contained minimum cooking time and cooking loss and more nutrients and also scored the maximum score for all the sensory attributes among the other cereal pulse blended samples. All the spaghetti samples packed in packaging material P_2 retained more nutrients than P_1. P_2 had lesser microbial load than P_1. Cereal pulse blended spaghetti packed in both the packaging material (P_1 and P_2) had an equal acceptability interms of organoleptic characteristics during storage. The cost of production of cereal pulse blended spaghetti is lesser than the market sample.

Key words: Cereal pulse blends, Cooking quality, Pasta products, Spaghetti.

INTRODUCTION

Pasta products are one of the most ancient food forms in which wheat has been consumed. Pasta products are becoming increasingly popular not only worldwide but also in the Indian subcontinent. This is because pasta products are simple to make and if dried they can be stored for relatively long periods of time (Oberoi *et al*., 2007). Spaghetti is the most popular and common variety among the hundreds of shapes of pasta products. Spaghetti as a shelf stable convenience product appeared in the Indian market in recent times. It is a very popular product now in India and the most preferred food of every child and adult alike (Sanghvi, 2008). In India, people who are vegetarian mostly depend on cereals and pulses as their staple foods which serve as a main source of dietary protein and energy. Cereals are the cheapest source of food energy and contribute 70-80 per cent of daily energy intake (Mahajan and Chattopadhyay, 2000). But they have relatively low protein content and poor protein quality due to deficiency of one or two essential amino acids (Gopalan *et al*., 2007). Rice contains less protein (7 per cent) than wheat and other cereals, but its quality is better. It has balanced amino acids composition with good source of methionine. The rice proteins are rich in arginine but deficient in lysine and threonine (Bhatia, 2008). Grain sorghum is rich in carbohydrates like other cereals and millets and contains water soluble B-complex vitamins and minerals. Among the rural people who subsist on cereals and millets, sorghum is the main source of protein and calories. Green gram contains about 25 per cent protein which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. Among legumes, green gram ranks third in the national production (Jha and Prasad, 2003). The nutritional value of pasta products is not very high, as it is rich in starch, whereas its protein concentration and quality is significantly lower. Hence an effort was made to prepare spaghetti incorporated with cereals and pulses such as wheat semolina, rice, sorghum and green gram which are easily available and a good source of protein.

MATERIALS AND METHODS

Flour processing: The raw ingredients such as wheat semolina, rice, sorghum and green gram whole were cleaned to remove immature, weeviled grains and other foreign substances and then dried. All the grains were ground into flour in a local flour mill. Spaghetti were prepared using 100 per cent wheat semolina flour and kept as control samples. Rice flour, sorghum flour and green gram flour were

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mixed in various proportions to develop spaghetti by the addition of salt and water. The proportions of the composite flours that were used to prepare spaghetti is given in Table 1.

TABLE 1. Proportion of composite flours used for the study

Treatments	Wheat Semolina Flour (g)	Cereal Pulse Blends		
		Rice flour (g)	Sorghum flour (g)	Green gram flour (g)
T_0	100	-	-	-
T_1	85	5	5	5
T_2	70	10	10	10
T_3	55	15	15	15
T_4	25	25	25	25

Procedure for the preparation of spaghetti: The cereal pulse blends were weighed and added with wheat semolina flour followed by the addition of salt and mixed well. The composite flours were then sifted thrice to ensure thorough and uniform blending. The composite flours were weighed and fed in the barrel of extruder. They were mixed thoroughly in the extruder by the shaft in the extruder. The mass was allowed to blend for 10-15 minutes to ensure thorough distribution of moisture. During mixing the required amount of water was added. The product was extruded using appropriate die. After extrusion, the spaghetti was then steamed for 20 minutes using idly steamer. The steamed spaghetti were then cooled and dried in cabinet drier for 6-8 hours at 60°C. The dried spaghetti were cooled and packed in two different packaging materials (Polyethylene bags of 200 gauge P_1 and Polyethylene bags of 400 gauge P_2) and kept for 180 days at room temperature.

The quality and storage stability of dried spaghetti were studied by analyzing cooking quality (Grant *et al.* 2004), moisture content (AOAC, 1995), protein (Ranganna, 1995), fat (Cohen, 1917), crude fibre (Maynard, 1976), ash content (Hart and Fisher, 1971) and total plate count (Istavankiss, 1984). The sensory attributes like colour, appearance, flavour, texture, taste and overall acceptability of vegetable, mushroom, egg and chicken spaghetti were evaluated by a panel of ten untrained judges by using a score card with a nine point hedonic scale (Larmond, 1970). Cost analysis of cereal pulse blended spaghetti were computed taking into account the fixed cost, variable cost, interest, depreciation and products profit. The data obtained were subjected to statistical analysis to find out the impact of packaging materials and storage periods on the quality of the cereal pulse blended spaghetti. Factorial completely randomised design (FCRD) was applied for the analysis of the study as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Cooking quality of cereal pulse blended spaghetti during storage: The changes in cooking qualities of the control and the cereal pulse blended spaghetti are tabulated in Table 2. The initial cooking time of spaghetti ranged between 6.40

TABLE 2. Changes in the cooking quality of cereal pulse blended spaghetti during storage

Cooking Quality	Treatments																		Stat value	
	T_0				T_1				T_2				T_3				T_4			
		P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2	S.E.	CD 0.05%
	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F		
Cooking Time (mins)	10.30	11.38	10.30	11.37	9.00	10.32	9.00	10.29	8.18	9.14	8.18	9.32	7.13	8.53	7.13	8.39	6.40	8.02	6.40	7.60	0.023	0.046**
Cooked Volume (ml/100g)	228.5	233.2	228.5	233.6	223.0	229.4	223.0	230.0	219.5	227.1	219.5	227.5	216.8	222.2	216.8	222.7	209.2	215.1	209.2	215.7	0.017	0.035**
Cooked Weight (g/100g)	285.6	291.6	285.6	292.9	278.7	286.8	278.7	287.5	274.4	283.9	274.4	284.4	271.1	277.8	271.1	278.4	261.6	268.9	261.6	269.7	0.008	0.016**
Water Absorption (ml/100g)	148.5	153.3	148.5	153.5	143.0	149.4	143.0	149.4	139.5	147.1	139.5	147.5	136.8	142.2	136.8	142.8	130.7	135.9	130.7	136.1	0.008	0.017**
Cooking Loss (%)	7.45	7.69	7.45	7.68	7.57	7.85	7.57	7.84	7.93	8.17	7.93	8.15	8.11	8.26	8.11	8.25	8.16	8.43	8.16	8.41	0.009	0.018NS

I - Initial, F- Final, ** Highly significant, NS Non significant

and 10.30 minutes. At the end of storage period a slight increase in cooking time was observed and it ranged between 7.60 and 11.38 minutes. The cooking time of cereal pulse blended spaghetti decreased with increased level of incorporation of cereal pulse blends. Spaghetti packed in P_2 had exhibited less cooking time when compared P_1. Vijayalakshmi (2004) reported that a gradual increase was noted in the cooking time of spaghetti fortified with different combinations of fruit pulps during 360 days of storage and also stated that the cooking time mainly depend on the density of the product. Protein content in the products had also high impact on the cooking time of the products.

The cooked weight, cooked volume and water absorption for spaghetti decreased with increased level of incorporation of cereal pulse blends. On storage cooked weight, cooked volume and water absorption considerably increased in all the spaghetti samples. Vani (2001) observed that the cooked volume of noodles increased with increased storage period. She also found that as the incorporation of pulse flour increased, the cooked volume decreased. Kalavathy (2002) reported that the cooked weight of noodles incorporated with green gram, ragi and carrot was increased during 180 days of storage. Mridula *et al.* (2008) stated that the water absorption decreased gradually with increase in the level of sorghum flour, may be due to decrease in cooking time of noodle samples with different proportion of sorghum flour.

Cereal pulse blended spaghetti had the maximum cooking loss of 8.16 (T_4) followed by 8.11 (T_3), 7.93 (T_2) and 7.57 (T_1) per cent. On storage, cooking loss was gradually increased to 7.85-7.84; 8.17-8.15; 8.26-8.25 and 8.43-8.41 per cent for T_1 to T_4 spaghetti packed in P_1 and P_2 respectively. The P_1 and P_2 had lesser but significant impact on cooking loss during storage. Bahnassey and Khan (1986) reported the increased cooking losses with standard pasta (noodle and spaghetti - types) when fortified with legume flour and protein concentrates. The maximum cooking loss would be 8 per cent. Sowbhagya and Ali (2001) opined that a solid loss of less than six per cent is considered very good and about eight per cent is average. Based on the cooking quality characteristics, the treatment (T_2) was found to be the best which had the minimum cooking time and cooking loss.

Nutritional composition of cereal pulse blended spaghetti during storage: Moisture, protein, fat, crude fibre and ash content of spaghetti were analysed during storage. Table 3 indicates the changes in the nutritional composition of cereal pulse blended spaghetti during storage. The control spaghetti sample had the moisture content of 6.60 per cent and cereal pulse blended spaghetti had moisture of 6.69 per cent in T_1, 6.71 per cent in T_2, 6.74 per cent in T_3 and 6.78 per cent in T_4 initially which gradually increased during storage. Hegde (1997) stated that the moisture content of green gram flour incorporated cassava noodles gradually increased during 180 days of storage. Sugasini (2003) found that there was an increasing trend in moisture content in legume and varagu incorporated vermicelli packed in different packaging materials at the 120 days of storage. The least increase was observed in the sample packed in MPP (P_3).

The initial protein content of the cereal pulse blended spaghetti ranged between 10.92 and 12.87 g/100g. The control as well as cereal pulse blended spaghetti showed a reduction in their protein content during the storage period. The P_1 and P_2 had lesser but significant impact on protein content during storage. Thirumaran *et al.* (1992) reported that the processing of sweet potato flour for the production of vermicelli and spaghetti which was prepared by mixing with wheat flour and legume flours like green gram, bengal gram or defatted soy flour to increase the protein level of the product. Vermicelli was rated acceptable with the addition of 20 per cent legume flour.

A mild reduction in fat content was observed during storage of 180 days. In the cereal pulse blended spaghetti sample T_4 had higher fat (1.013 g/100g) followed by T_3, T_2 and T_1. Cereal pulse blended spaghetti had crude fibre content ranging from 0.541-1.527 g/100g in T_1 to T_4 samples. Sugasini (2003) stated that the incorporation of bengalgram whole and peas considerably increased the crude fibre content of legume incorporated wheat vermicelli. The reduction in the fat content of legume (Bengal gram and peas) and varagu incorporated vermicelli packed in different packaging materials was found to be negligible during storage.

In cereal pulse blended spaghetti T_4 had 2.626 g/100g of ash which was the highest among all samples. This was followed by T_3 (2.517 g/100g) and T_2 (2.343 g/100g). These samples also had only negligible change during storage irrespective of the packaging material 1.503-1.635 g/100g (T_1), 1.747-1.877 g/100g (T_2), 1.975-2.008 g/100g (T_3) and 2.085-2.119 g/100g (T_4) of ash. Hemalatha (2004) reported that increase in ash content over control (0.71%) was observed with increase in the level of incorporation (10 and 20%) of little millet flour (0.88 and 1.05% respectively) and kodo millet flour (0.95 and 1.26% respectively). Mridula *et al.* (2008) stated that a linear increase in total ash was observed with increased proportion of sorghum flour in noodles.

Organoleptic characteristics of cereal pulse blended spaghetti during storage: The control spaghetti had dark brown colour. The spaghetti had smooth edges and firm texture. The control spaghetti had cooked starchy flavour. The cereal pulse blended spaghetti had the colour of light brown to yellow (T_1 to T_4) during the initial storage period. The scores of the organoleptic characteristics of the cereal pulse blended spaghetti during storage are tabulated in Table 4. Initially all the criteria like colour, appearance, flavour, texture and taste received similar and sometimes higher scores than control sample. T_1 and T_2 samples scored the

TABLE 3. Changes in the nutritional composition of cereal pulse blended spaghetti during storage

Nutrient content	Treatments																				Stat value	
	T_0				T_1				T_2				T_3				T_4				S.E.	CD 0.05%
	P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2			
	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F		
Moisture Content (%)	6.60	6.81	6.60	6.76	6.69	6.88	6.69	6.82	6.71	6.91	6.71	6.84	6.74	6.92	6.74	6.86	6.78	6.98	6.78	6.95	0.13	0.27^{NS}
Protein (g/100g)	10.23	9.27	10.23	9.45	10.92	10.18	10.92	10.24	11.37	10.69	11.37	10.71	12.25	11.26	12.25	11.35	12.87	12.20	12.87	12.24	0.68	1.37^{**}
Fat (g/100g)	0.785	0.625	0.785	0.660	0.840	0.690	0.840	0.731	0.905	0.735	0.905	0.781	0.957	0.811	0.957	0.841	1.103	0.939	1.103	0.981	0.10	0.21^{NS}
Crude Fibre (g/100g)	0.365	0.162	0.365	0.184	0.541	0.353	0.541	0.371	0.995	0.754	0.995	0.770	1.180	0.881	1.180	0.901	1.527	1.256	1.527	1.272	0.021	0.43^{**}
Ash Content (g/100g)	1.980	1.286	1.980	1.312	2.102	1.503	2.102	1.635	2.343	1.747	2.343	1.877	2.517	1.975	2.517	2.008	2.626	2.085	2.626	2.119	0.031	0.63^{NS}

I - Initial, F- Final, ** Highly significant, ^{NS} Non significant

TABLE 4. Mean scores of quality attributes of cereal pulse blended spaghetti during storage

Quality Attributes	Treatments																			
	T_0				T_1				T_2				T_3				T_4			
	P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2	
	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F
Colour and appearance	8.5	8.3	8.6	8.3	8.4	8.2	8.4	8.2	8.3	8.2	8.4	8.2	8.2	8.0	8.2	8.0	8.2	7.8	8.3	7.9
Flavour	8.7	8.3	8.7	8.4	8.6	8.2	8.6	8.2	8.6	8.3	8.6	8.2	8.5	8.2	8.5	8.2	8.4	8.1	8.4	8.1
Texture	8.5	8.2	8.6	8.2	8.5	8.2	8.5	8.2	8.4	8.2	8.4	8.2	8.3	8.1	8.4	8.1	8.3	8.0	8.3	8.0
Taste	8.4	8.1	8.5	8.1	8.4	8.1	8.4	8.7	8.5	8.1	8.4	8.0	8.3	7.9	8.4	8.0	8.2	7.9	8.3	8.0
Overall acceptability	8.52	8.22	8.6	8.25	8.47	8.17	8.47	8.17	8.45	8.2	8.45	8.15	8.32	8.05	8.37	8.07	8.27	7.95	8.32	8.0

maximum score for all the sensory attributes among the other cereal pulse blended samples. During storage a reduction in organoleptic characteristics was noticed in all the spaghetti samples. Cereal pulse blended spaghetti packed in both the packaging (P_1 and P_2) had an equal acceptability during storage The packaging did not influence the organoleptic characteristics of cereal pulse blended spaghetti. A reduction in overall acceptability was noticed in all the spaghetti samples during 180 days of storage.

Vegetable, mushroom, egg and chicken spaghetti were prepared from cereal pulse blended spaghetti. T_2 secured the highest score for overall acceptability in all the recipes followed by T_1, T_3 and T_4 samples. The spaghetti based recipes had scores for organoleptic characteristics on par with their control sample.

Microbial load of stored cereal pulse blended spaghetti: The microbial load of the samples found to be within the permissible limit even after 180 days of storage (Table 5). The cereal pulse blends were devoid of coliforms and *Staphylococcus aureus*. The count of *Staphylococcus aureus* were in the range of 1.33-1.36 x 10^3 cfu/g in stored spaghetti. The microbial evaluation indicates that the product was free from coliforms, *Staphylococcus aureus* were within the safe limits (APHA, 2001). Swartzentruber *et al*. (1982) reported that the counts of coliforms and *Staphylococcus aureus* were less than 3 per g for both macaroni and noodles. *Escherichia coli* were not found in macaroni but were present at the level of 0.5 per cent in noodle samples and ranged from 3 to 93 per gram.

Cost analysis: The cost of production of the control spaghetti was Rs.18.59 per 250g. The market price of the spaghetti was found to be Rs. 25.00 to 30.00 whereas the cost of cereal pulse blended spaghetti was ranging from Rs. 19.10 to 21.15.

CONCLUSION

In conclusion the cooking qualities like cooking time, cooked weight, cooked volume and water absorption was decreased with the addition of cereal pulse blends except for cooking loss. An increasing trend in moisture and a decreasing trend in protein, fat, crude fiber and ash content were noticed in the cereal pulse blended and control spaghetti samples during storage. Highly acceptable spaghetti interms of colour, appearance, flavour, texture and taste could be prepared by incorporating cereal pulse blends. T_1 and T_2 samples was found to be the best treatment s which contained minimum cooking time and cooking loss and more nutrients and also scored the maximum score for all the sensory attributes among the other cereal pulse blended samples. Spaghetti packed in P_2 (400 gauge) polyethylene bags had maximum retention of nutrients than in P_1 (200 gauge) during storage. Minimum increase in the microbial population was observed in the stored spaghetti in both control and cereal pulse blended spaghetti. The cost of cereal pulse blended spaghetti was found to be less when compared to the market samples.

TABLE 5. Changes in microbial load (x 103 cfu/g) of cereal pulse blended spaghetti during storage

Microbial load	Treatments																			
	T_0				T_1				T_2				T_3				T_4			
	P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2		P_1		P_2	
	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F
Bacterial Population (10^3 cfu/g)	0.34	1.45	0.34	1.34	0.32	1.35	0.32	1.33	0.34	1.25	0.34	1.23	0.31	1.23	0.31	1.18	0.33	1.13	0.33	1.04
Fungal Population (10^2 cfu/g)	0	4	0	3	0	6	0	5	0	5	0	5	0	6	0	5	0	5	0	4
Yeast Population (10^3 cfu/g)	0	4	0	4	0	4	0	3	0	4	0	3	0	3	0	2	0	3	0	3

I - Initial, F- Final

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