International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2502-2507

Received: 11-05-2018
Accepted: 17-06-2018

Nataraja BS
Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

Jain SK
Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

Jain NK
Department of Dairy and Food Technology, College of Dairy and Food Science Technology, MPUAT, Udaipur, Rajasthan, India

Wadhawan N
Department of Dairy and Food Technology, College of Dairy and Food Science Technology, MPUAT, Udaipur, Rajasthan, India

Khidiya MS
Department of Mechanical Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

Correspondence
Nataraja BS
Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

Process development of pasta from sprouted and whole grains

Nataraja BS, Jain SK, Jain NK, Wadhawan N and Khidiya MS

Abstract
The use of gluten-free products is increasing since a growing number of people are suffering from celiac disease and thereby need gluten-free diet. The present study was aimed to develop multigrain pasta by partially substituting wheat flour with maize, soybean and bengal gram and fortify the sprouted grain paste in the developed multigrain pasta. Pasta was developed using single screw extruder. Sprouted grain paste of the individual grains was fortified in the multigrain pasta at 5%, 10%, 15% and 20% level of the individual grain quantity on dry basis. Nutritional analyses of pasta were made along with physical properties namely water solubility index, water absorption index and colour were also analysed. The organoleptic qualities of developed pasta samples were analysed by panellists on a nine point hedonic scale. The results indicated that pasta combination with 20% sprouting incorporation level can be used to produce quality pasta product.

Keywords: Pasta, food, sprouts, nutritional quality

Introduction
India ranks second in worldwide farm output. The production of grains such as rice, wheat, maize, soybean and bengal gram was 109.68, 98.51, 25.90, 13.159 and 11.26 million tonnes respectively in 2017 (anonymous, 2018) [1]. Utilization of other grains apart from the wheat in the production of pasta increases the demand for other grains thereby farmers will going to increased demand for their produce.

Pasta is a very well-known Italian food and its consumption is globally widespread next to bread. Pasta products are an inexpensive food usually manufactured using only durum wheat flour, which is well accepted worldwide because of its easy preparation, versatility, sensory attributes and long shelf-life (Bergman, *et al*., 1994**)** [2]. The key feature durum wheat includes its hardness, intense yellow colour and nutty taste (Sissons, M, 2008) [3]. It is extremely digestible because its carbohydrates suffer some fission processes that help digestion and its assimilation by our organism (Temmerman *et al.*, 2007) [4].

In the last few years, flours from different products have been used to substitute durum wheat semolina, either totally or partially, in some pasta products to satisfy the nutritional need of specific people such as those following a coeliac diet (Chillo *et al.*, 2010) [5].

In the last decades, consumer demands in the field of food production have changed considerably. Consumers more and more believe that foods contribute directly to their health (Young, 2000; Mollet and Rowland, 2002) [6, 7]. Today foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers (Roberfroid, 2000; Menrad, 2003) [8, 9]. In this regard, functional foods play an outstanding role. The appeal of pasta amongst consumers has made this food product a potential vehicle for highly nutritious compounds. Pasta products can be fortified with supplements from various high protein sources to improve their nutritional properties (Marconi and Carcea, 2001) [10].

Epidemiological studies indicate that the consumption of whole grains and whole-meal cereal products reduces the risk of cardiovascular diseases, cancer, and diabetes (Chatenoud *et al*., 1998; Koh-Banerjee and Rimm 2003) [11, 12]. In recent years, scientific evidence exalting the physiological, nutritional, and therapeutical effects of various ingredients has led to the incorporation of those into various food products including pasta (Krishnan, M and Prabhashankar, P, 2012) [13].

Sprouting of the grains is an age-old practice in order to increase the quality of the grains. The consumption of sprouted cereals is becoming popular in various parts of the world.

Sprouting of grains for a limited period causes increased activities of hydrolytic enzymes, improvement in the contents of certain essential amino acids, total sugars, and B-group vitamins, and a decrease in dry matter, starch, and anti-nutrients. The digestibility's of storage proteins and starch are improved due to their partial hydrolysis during sprouting (Chavan *et al.,* 1989) [14].

Considering the above facts it is thought to be worth full to study the effect of fortification of sprouted grains in the multigrain pasta the current research work was under taken.

Materials and Methods

Selection of Raw Material

The raw materials used in this study such as wheat, maize, soybean and bengal gram were procured from the Udaipur local market. All raw materials were cleaned and grounded separately in grinder and passed through BSS no.16 sieve. Before milling cleaned soybeans were steeped in water at room temperature (30 ± 2°C) for some hours and washed properly followed by draining of water. They were then allowed to boil for 20 min to remove any anti-nutritional factors and beany flavour present in the grain. The beans were dried in tray dryer at low temperatures of 65°C for 3 – 5 hours (Adegunwa *et al.,* 2012) [15]. The rice flour was purchased from the local store which is used as additive (200 g/kg of raw material).

Pasta Extruder

Extrusion is the act or process of shaping material by pushing or forcing through a die. Pasta was developed using cold extruder machine "La Parmigiana" model ANNA-A45 (Pasta producing machine).

Preparation of multigrain blend

The blends of wheat, maize, soybean and bengal gram flour were taken in the ratio of 65:15:10:10 respectively. The blend ratio was fixed based on the acceptable cooking quality of pasta on trial and error basis method.

Production of Sprouts

The grains were steeped in water for 8-12 hours followed by washing. The steeped wheat, maize and bengal gram were tied in cloth and kept in dark place for sprouting for 2 days at 30°C with relative humidity around 60 per cent. Soybeans were sprouted by keeping in sprouting tray and covered by cloth and rinsing 2-3 times per day. The sprouted grains were grinded in grinder to prepare fine paste.

Fortification of blend with sprouts

The blend combination of multigrain was incorporated with sprouted grain paste at 5, 10, 15 and 20 per cent level of respective grain quantity in the blend ratio. The experimental treatments are presented in the Table 1.

Table 1: Experimental design of the treatments

Treatment	Composition of whole and sprouted grains in per cent pasta							
	Wheat		Maize		Soybean		Bengal gram	
	WF	SP	WF	SP	WF	SP	WF	SP
C	65	0	15	0	10	0	10	0
WL_1	61.75	3.25	15	0	10	0	10	0
WL_2	58.50	6.50	15	0	10	0	10	0
WL_3	55.25	9.75	15	0	10	0	10	0
WL_4	52.13	13.0	15	0	10	0	10	0
ML_1	65	0	14.25	0.75	10	0	10	0
ML_2	65	0	13.50	1.50	10	0	10	0
ML_3	65	0	12.75	2.25	10	0	10	0
ML_4	65	0	12.0	3.0	10	0	10	0
SL_1	65	0	15	0	9.5	1.0	10	0
SL_2	65	0	15	0	9.0	1.0	10	0
SL_3	65	0	15	0	8.5	1.5	10	0
SL_4	65	0	15	0	8.0	2.0	10	0
BL_1	65	0	15	0	10	0	9.5	1.0
BL_2	65	0	15	0	10	0	9.0	1.0
BL_3	65	0	15	0	10	0	8.5	1.5
BL_4	65	0	15	0	10	0	8.0	2.0
CL_1	61.75	3.25	14.25	0.75	9.5	1.0	9.5	1.0
CL_2	58.50	6.50	13.50	1.50	9.0	1.0	9.0	1.0
CL_3	55.25	9.75	12.75	2.25	8.5	1.5	8.5	1.5
CL_4	52.13	13.0	12.0	3.0	8.0	2.0	8.0	2.0

WF – Whole flour, SP – Sprout paste, W - Wheat, M - Maize, S - Soybean, B – bengal gram, C – combined, $L_{1,2,3,4}$ – level 1, 2, 3 and 4 respectively

Product Analysis

Water Solubility Index (WSI) and Water Absorption Index (WAI)

The WSI and WAI were measured using a technique developed for cereals (Anderson *et al.,* 1969) [16]. The pasta samples were milled to mean particle size of 200-250 µm. A sample of 2.5 g was dispersed in 25 ml distilled water at room temperature for 30 min, with intermediate stirring using glass rod to break up any lumps. The dispersion was then centrifuged at 3000 for 15 min. The supernatant was decanted into an evaporating dish with a known weight. The WSI was the weight of dry solids in the supernatant expressed as a percentage of the original weight of sample, whereas WAI was the weight of gel obtained after removal of the supernatant per unit weight of original dry solids. These were calculated using following formulas;

$$\text{Water absorption index (g/g)} = \frac{\text{Grams of water held by product}}{\text{Weight of product}}$$

$$\text{Water solubility index (\%)} = \frac{\text{Weight of dissolved product in supernatant}}{\text{Weight of product taken}} \times 100$$

The test was done in triplicates and the average value was reported.

Colour

The values of surface color of raw pasta in terms of lightness (L*) and color (+a: red; -a: green; +b: yellow; -b: blue) were measured using Hunter Lab color measuring system (Model CFLX/DIFF, CFLX-45). The test was done in triplicates and the average value was reported.

Sensory Evaluation

Sensory analysis is the scientific discipline used to measure, analyse and interpret reactions to those characters of food material, as they are perceived by the sense of sight, smell, taste, touch and hearing. In general, the sensory quality of food is the consumer reaction to the physical and chemical constituents of food in the prepared and formulated form.

Sensory evaluation indicates the acceptability of the product. Acceptability of pasta was judged, on a nine point hedonic scale. The sensory evaluation was carried out on the basis of colour, flavour, taste, appearence and overall acceptability of the developed product. The sensory evaluation of the pasta product revealed that there were significant differences among the treatments for the organoleptic qualities (Ranganna, 1995) [17].

Statistical Analysis

All experiments in the present investigation were conducted in triplicate and mean values were reported. General Factorial Completely Randomised Design (CRD) was used to analyse the data. After proper analysis, data were accommodated in the tables as per the needs of objectives for interpretation of results. Statistical significance of the terms in the regression equation was examined by analysis of variance (ANOVA) for each response. The p-values were used as a tool to check the significance of each of the coefficients, which, in turn were necessary to understand the pattern of the mutual interactions between the test variables. The smaller the magnitude of p, the more significant is the corresponding coefficient. Values of p less than 0.0001 indicate the model terms to be significant (Montgomery, 2001) [18].

Results Discussions

Physical Characteristics

The physical properties of developed pasta product such as water absorption index, water solubility index and colour were determined. The average values of physical properties of developed pasta for all treatments are given in Table 2.

Table 2: Physical properties of the developed pasta

Treatmens	WSI (%)	WAI (g/g)	color values		
			*L**	*a**	*b**
C	9.07	2.11	68.22	1.85	16.72
WL_1	9.09	2.08	69.13	1.76	16.51
WL_2	9.10	2.07	71.65	1.70	16.25
WL_3	9.11	2.05	73.16	1.58	15.86
WL_4	9.12	2.04	76.02	1.49	15.17
ML_1	9.08	2.09	69.24	1.81	16.96
ML_2	9.09	2.08	69.63	1.78	17.05
ML_3	9.09	2.07	70.83	1.71	17.09
ML_4	9.10	2.06	72.22	1.66	17.14
SL_1	9.08	2.10	69.62	1.80	16.79
SL_2	9.09	2.09	71.41	1.69	16.56
SL_3	9.10	2.08	72.29	1.66	16.26
SL_4	9.11	2.07	73.65	1.61	15.95
BL_1	9.08	2.10	68.53	1.89	16.75
BL_2	9.09	2.09	68.08	1.91	16.52
BL_3	9.10	2.08	67.65	1.95	16.20
BL_4	9.10	2.07	67.04	2.08	15.93
CL_1	9.10	2.07	68.96	1.82	16.79
CL_2	9.12	2.04	69.32	1.76	16.56
CL_3	9.13	2.01	70.09	1.73	16.29
CL_4	9.15	1.98	72.05	1.70	16.09

WSI – Water solubility index; WAI – Water absorption index

Water Solubility Index (WSI)

WSI is used as an indicator of degradation of molecular components. It measures the amount of soluble polysaccharide released from the starch component after extrusion (Ding *et al.*, 2005) [19]. The WSI was ranged from 9.07 to 9.15 (%) for the pasta samples. The maximum WSI (9.15 %) was observed for treatment CL_4 *i.e.* pasta having sprouting level of 20% of all the grains, minimum WSI (9.07 %) was observed for treatment C *i.e.* pasta without any sprouts incorporation.

Figure 1 shows the effect sprouting level on WSI of pasta. The increase in WSI with increased level of sprouting incorporation is due to increase in amylolytic and proteolytic activity (Singh *et al.*, 2001) [20].

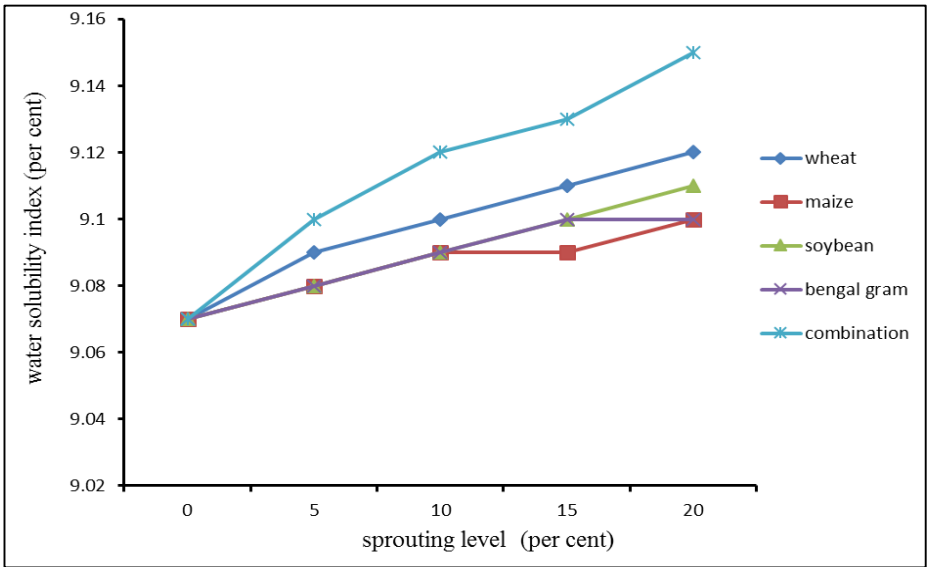

Fig 1

Water Absorption Index (WAI)

WAI WAI measures the amount of water absorbed by starch that can be used as an index of gelatinization and it is generally agreed that barrel temperature and feed moisture exert greatest effect on the WAI of the extrudate by promoting gelatinization (Ding *et al.*, 2005) [19]. The WAI was ranged from 1.98 to 2.11 (g/g) for the pasta samples. The maximum WAI (2.11 g/g) was observed for treatment C *i.e.* pasta without any sprouts incorporation, minimum WAI (1.98 g/g) was observed for treatment CL_4 *i.e.* pasta having sprouting level of 20% of all the grains.

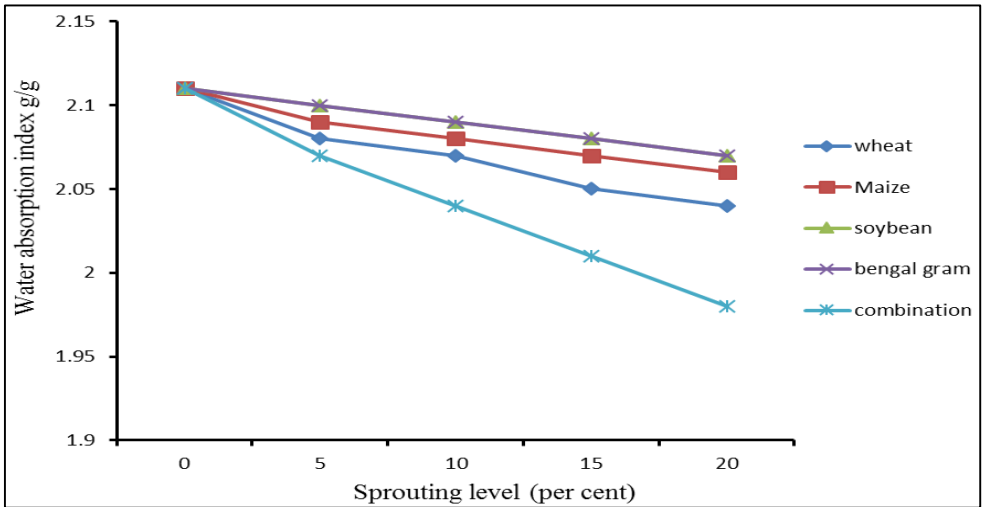

Fig 2

Figure 2 shows the effect of fortification of sprouting level on WAI of multigrain pasta. The decrease in WAI with increased level of sprouting incorporation is due to decrease in damaged starch content (Singh *et al.*, 2001) [20].

Color Value

***L** Value**

The colour *L** value indicates the whiteness of the product. From the Table, it can be seen that, the *L** value of the pasta was varied from 67.04 to 76.02 among all the treatments. The maximum value *L** was found in treatment WL_4 *i.e.*, pasta having wheat sprouts incorporation at 20% level, minimum *L** was found in treatment BL_4 *i.e.*, pasta having Bengal gram sprouting incorporation at 20%.

Figure 3 shows the effect of fortification of sprouting level on colour *L** value of multigrain pasta. The variation in colour *L** value with differed levels of sprouting incorporation is due to colour of the sprouted grain pigments of the individual grain and variation in the nutritional properties of the pasta (Feillet *et al.*, 2000) [21].

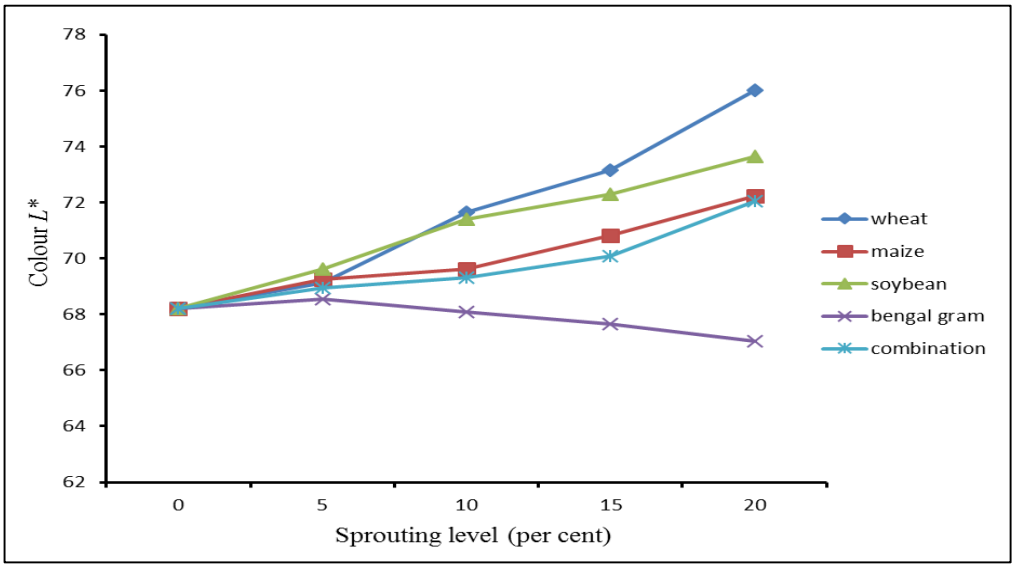

Fig 3

a* Value

The colour *a** value indicates the redness of the product. From the Table, it can be seen that, *a** value of the pasta was varied from 1.58 to 2.08 among all the treatments. The maximum value *a** was found in treatment BL_4 *i.e.*, pasta having Bengal gram sprouting incorporation at 20%, minimum *a** was found in treatment WL_4 *i.e.*, pasta having wheat sprouts incorporation at 20% level.

Figure 4 shows the effect of incorporation of sprouting level on colour *a** value of multigrain pasta. The variation in *a** value with increased level of sprouting incorporation is due to colour pigmentation of the different grain flours (Susanna *et al.*, 2012) [22]. (Schoenlechner *et al.*, 2010 and Lucisano *et al.*, 1984) [23, 24] reported decrease in reddishness with increased level of corn.

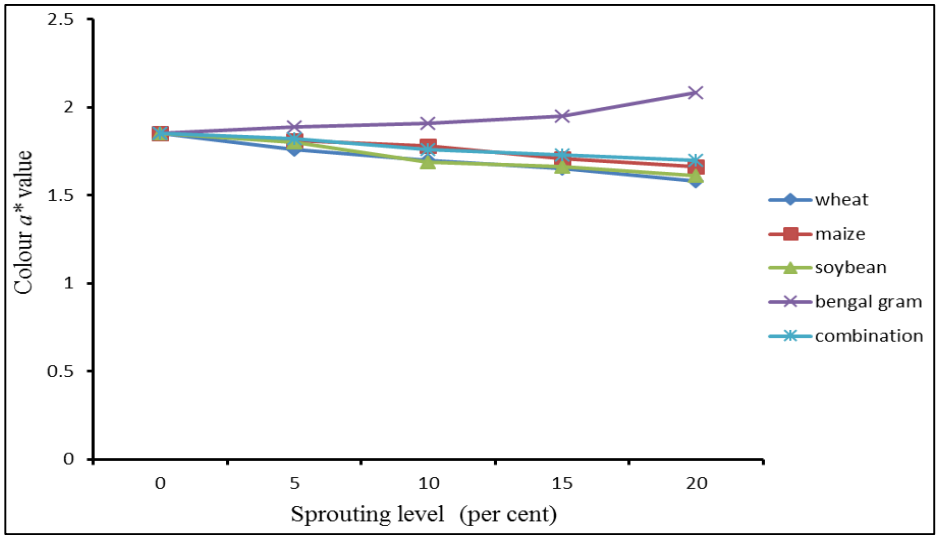

Fig 4

b* Value

The colour *b** value indicates the redness of the product. From the Table, it can be seen that, *b** value of the pasta was varied from 15.17 to 17.14 among all the treatments. The maximum value *b** was found in treatment ML_4 *i.e.*, pasta having maize sprouting incorporation at 20%, minimum *b** was found in treatment WL_4 *i.e.*, pasta having wheat sprouts incorporation at 20% level.

Figure 5 shows the effect of fortification of sprouting level on colour *b** value of multigrain pasta. The variation in *b** value with increased level of sprouting incorporation is due to decrease in starch content of flours (Fiorda *et al*., 2013) [25].

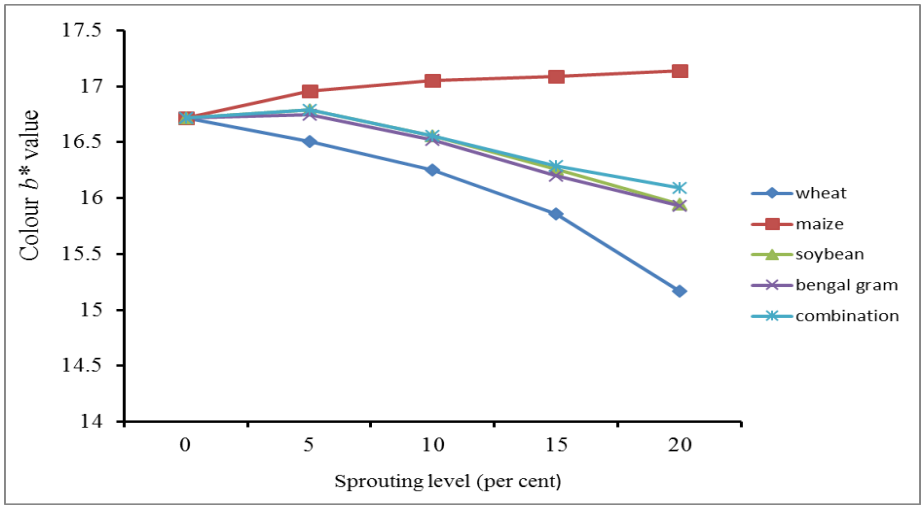

Fig 5

Sensory Evaluation

Sensory evaluation indicates the acceptability of the product. Acceptability of pasta was judged, on a nine point hedonic scale. The sensory evaluation was carried out on the basis of colour, flavour, taste, appearance and overall acceptability of the developed product. The sensory evaluation of the pasta samples revealed that there were significant differences among the treatments for the organoleptic qualities. The quality was judged by the consumer panel team consisting of fifteen members. Overall acceptability of pasta ranged from 8.75 to 7. The treatment WL_4 mostly accepted by sensory panel (overall acceptability 8.75) whereas, the treatment CL_4 was rejected by sensory panel (overall acceptability 7.00). The second best treatment selected by sensory panel was WL_3 with overall acceptability 8.50.

Conclusions

Pasta supplemented with maize, soybean and Bengal gram along with wheat can be produced with blend ratio 65:15:10:10 of wheat, maize, soybean and bengal gram respectively with acceptable quality. With the increased level of sprouted grain incorporation, overall acceptability of the pasta was found to be decreasing. Pasta having 20% sprouting incorporation of wheat grain was found to be more acceptable.

References

1. Anonymous. Directorate of Economics and Statistics, Government of India, 2018. https://www.indiastat.com/table/agriculture/2/rice/17194/1096352/data.aspx.
2. Bergman CJ, Gualberto DG, Weber CW. Development of a high-temperature-dried soft wheat pasta supplemented with cowpea (*Vigna unguiculata* (L.) Walp). Cooking quality, color, and sensory evaluation. Cereal Chemistry. 1994; 71:523-527.
3. Sissons. Role of durum wheat composition on the quality of pasta and bread. Global Science Books, 2008; 2:75-90.
4. Temmerman JD, Verboven P, Nicolai B, Ramon H. Modelling of transient moisture concentration of

semolina pasta during air drying. Journal of Food Engineering. 2007; 80:892-903.
5. Chillo S, Civica V, Iannetti M, Mastromatteo M, Suriano N, Del Nobile MA. Influence of repeated extrusions on some properties of non-conventional spaghetti. Journal of Food Engineering. 2010; 100:329-335.
6. Young Y. Functional foods and the European consumer. In: Functional Foods II. Claims and Evidence (edited by J. Buttriss & M. Saltmarsh). London, UK: The Royal Society of Chemistry, 2000.
7. Mollet B, Rowland I. Functional foods: At the frontier between food and pharma. Current Opinion in Biotechnology. 2002; 13:483-485.
8. Roberfroid MB. An European consensus of scientific concepts of functional foods. Nutrition. 2000; 16:689-691.
9. Menrad K. Market and marketing of functional food in Europe. Journal of Food Engineering. 2003; 56:181-188.
10. Marconi E, Carcea M. Pasta from non-traditional materials. Cereal Foods World. 2001; 46:522-530.
11. Chatenoud L, Tavani A, La Vecchia C, Jacobs DR Jr., Negri E, Levi F *et al*. Whole grain food intake and cancer risk. International Journal of Cancer. 1998; 77:24-28.
12. Koh-Banerjee P, Rimm EB. Whole grain consumption and weight gain: A review of the epidemiological evidence, potential mechanisms and opportunities for future research. Proceedings of Nutrition Society. 2003; 62:25-29.
13. Krishnan M, Prabhasankar P. Health Based Pasta: Redefining the Concept of the Next Generation Convenience Food. Critical Reviews in Food Science and Nutrition. 2012; 52:9-20.
14. Chavan JK, Kadam SS, Beuchat LR. Nutritional improvement of cereals by sprouting. Critical Reviews in Food Science and Nutrition. 1989; 28:401-437.
15. Adegunwa MO, Bakare HA, Akinola OF. Enrichment of noodles with soy flour and carrot powder. Nigerian Food Journal. 2012; 30:74-81.
16. Anderson RA, Conway HF, Griffin JEL. Gelatinization of corn grits by roll and extrusion cooking. Cereal Science Today. 1969; 14:4-7.
17. Ranganna S. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. 2nd ed., Tata McGraw-Hill Pub. Co, Ltd., New Delhi, India, 1995.
18. Montgomery DC. Design and Analysis of Experiments, Wiley, New York, 2001, 416-419.
19. Ding Q, Ainsworth P, Gregory T, Hayley M. The effect of extrusion conditions on the physicochemical properties and sensory characteristics of rice-based expanded snacks. Journal of Food Engineering. 2005; 66:283-289.
20. Singh N, Hardeep S, Kaur L, Saxena SK. Effect of sprouting conditions on functional and dynamic rheological properties of wheat. Journal of Food Engineering. 2001; 47:23-29.
21. Feillet Pierre, Jean-Claude Autran, Christele Icard-Verniere. Pasta brownness: an assessment. Journal of Cereal Science. 2000; 32:215-233.
22. Susanna S, Prabhasankar P. A study on development of Gluten free pasta and its biochemical and immunological validation. LWT - Food Science and Technology. 2013; 50:613-621.
23. Schoenlechner R, Drausinger J, Ottenschlaeger, Jurackova K, Berghofer. Functional Properties of Gluten-Free Pasta Produced from Amaranth, Quinoa and Buckwheat. Plant Foods for Human Nutrition. 2010; 65:339-349.
24. Lucisano M, Casiraghi EM, Barbieri R. Use of defatted corn germ flour in pasta products. Journal of Food Science. 1984; 49:482-488.
25. Firoda FA, Soares Jr MS, Silva FA, Grosmann MV. Microestructure, texture and colour of gluten-free pasta made with amaranth flour, cassava starch and cassava bagasse. LWT - Food Science and Technology. 2013; 54:132-138.