Plant Archives Vol. 25, Supplement 1, 2025 pp. 1496-1501 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.206

DEVELOPMENT AND EVALUATION OF NUTRITIONAL PROPERTIES OF GLUTEN FREE PASTA

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(Date of Receiving : 28-08-2024; Date of Acceptance : 05-11-2024)

ABSTRACT

A gluten-free pasta has been developed based on the flour blends of Sorghum, Defatted Soy and Amaranth. The aim of the study was to investigate the effect of process parameters i.e., Blend Ratio produced from sorghum flour, defatted soyflour and amaranth flour (60:10:30, 60:15:25, 60:20:20, 60:25:15 and 60:30:10) where sorghum flour is fixed parameter, Guar gum (1, 1.5, 2, 2.5 and 3 %), Drying Temperature (50, 55, 60, 65 and 70 °C), and Air Flow Rate (1, 1.25, 1.5, 1.75 and 2 m/sec) on nutritional/chemical properties of gluten free pasta produced by a Pasta maker machine. The process uses response surface methodology based on central composite rotatable design (CCRD). Results shows that with regards to the flour blends of (SF:DSF:AF) sorghum, defatted soy and amaranth fortified pasta, the protein, fibre, ash content increases with increasing level of defatted soyflour whereas, the fat, carbohydrate and moisture content decreases with increasing level of defatted soyflour on pasta samples. The increase in drying temperature and airflow rate levels increases the moisture content in pasta samples. The best pasta samples were obtained at optimal conditions (blend ratio 60:20:20, guar gum 2%, drying temperature 60°C and airflow rate 1.5 m/sec).
***Keywords* :** Gluten free, nutritional properties, response surface methodology, defatted soyflour, optimal conditions.

Introduction

There is a global change in the composition of diet and lifestyle in the contemporary era of industrialisation, globalisation, fast urbanisation, busy lifestyles, and western influences. This not only developed a need for the basic processed ready-to-eat meals and food items, but it also made them unique. Because of its ease of preparation, affordability, adaptability, sensory qualities, and extended shelf life, pasta is often regarded among them (Bergman *et al.,* 1994). Although pasta is rich in calories, fat, salt and carbohydrates, it is mostly deficient in important nutrients, especially macro and micronutrients like protein, fibre, vitamins and minerals (Kaushik *et al.,* 2011; Serrem *et al.,* 2009). The protein gluten, which gives dough its elastic quality, is abundant in semolina (durum wheat), which is used for the production of pasta. Gluten present in wheat causes celiac disease, which damages the small intestine, produces indigestion, and messes with the diet's nutritional balance (Tomar *et al.,* 2022). This leads to the development of gluten-free pasta that has a higher protein level.

Sorghum is the most common millet crop, accounting for more than 65% of all millets. Because of its numerous uses and adaptations, sorghum is considered to be one of the truly necessary crops for human life. Economic development in emerging nations is greatly helped by the commercial processing of these locally cultivated grains into food and beverage items with additional value. Prior to now, sorghum was used primarily for animal feed and biofuel than for human consumption, but as sorghum gains popularity as a gluten-free wheat substitute, this number is rapidly increasing. Due to its high content of soluble fibre and antioxidants, the grain is rich in nutrients (Tomar *et al.,* 2023).

Defatted soybeans have a high protein content and a considerable level of lysine and isoflavone (as an antioxidant). It has been employed in the creation of many different foods, most recently pasta and macaroni products (Ansari *et al.,* 2013).

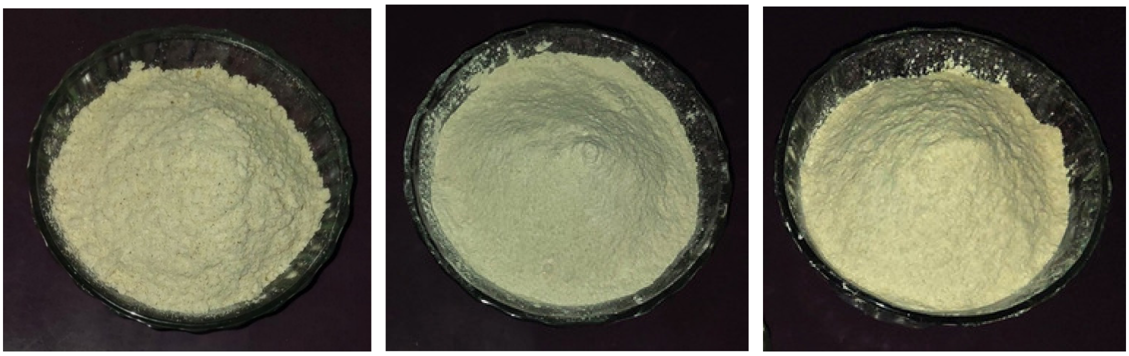
The pseudo-cereal amaranth (Family: Amaranthaceae) possesses the qualities of both a leguminous seed and a cereal. The recent identification of the limiting amino acids of the protein component is the nutritional aspect of the amaranth grain's food value that has been investigated the most. Amaranth has a high protein level of 12.5% to 19% and a substantial amount of both soluble and insoluble fibre. In comparison to other grains, it is a very nutritious grain with high levels of vitamins and minerals like riboflavin, niacin, ascorbic acid, calcium, and magnesium, as well as vital amino acids like methionine and lysine (0.73–0.84%) (Jatav *et al.,* 2016).

Guar (Cyanopsis tetragonolobus) seeds are a primary provider of gums, a type of galactomannan, which finds numerous uses in various industries. Gums are natural plant secretions and are frequently confused with resins, rubbers, and latex. Therefore, gums are substances that can either dissolve or disperse in water to create solutions or dispersions that are either thick or thin. Guar gum has the unique ability to create a thick solution even at low concentrations (Andhale *et al.,* 2019)

Material and Methods

Raw Material

The raw material used for the experiments were sorghum flour, defatted soy flour, amaranth flour, guar gum, CMC, edible oil and salt were purchased from local market in appropriate quantity.



Sorghum Flour **Defatted Soyflour** **Amaranth Flour**

Plate 1 : Raw Materials for Pasta Development

Experimental Details

The Raw material /Ingredients combinations for making pasta was presented in [Table-1].

Development of Pasta Samples

The pasta extruder machine (Make: K. K. LIFE SCIENCES, 21/41, Flat No.3, Sunkuvar Street, Triplicanve, Chennai-600005) located at the Department of Food Science and Technology, JNKVV, Jabalpur was used. Products were prepared at ambient conditions. Pasta samples were prepared by using steps of weighing, sieving, mixing, kneading, and extrusion process in a pasta extruder machine. The preparation of fortified pasta sample starts with mixing of different raw ingredients (sorghum flour, defatted soyflour and amaranth flour) and addition of oil, salt and water in pasta extruder machine followed by kneading in to a form of dough. Subsequently, the required amount of water was added to keep the moisture content around 32-35% in mixture. Mixing and kneading were carried out for an optimum time of 12-15 minute till it produces homogeneous dough. A sharp blade cutter was then fixed in front of the die in extrusion machine and the speed of the sharp blade cutter was adjusted as per the requirement, which cuts the dough in the desired shape and size of pasta samples. Finally, the fortified pasta samples were steamed for 9-12 minutes, and then dried in a tray drier at different ranges of temperature and air velocity for 3 hours followed by cooling at ambient room temperature for 30 min and then packed in commercially air tight LDPE poly bags/pouches.

Process of Pasta Preparation

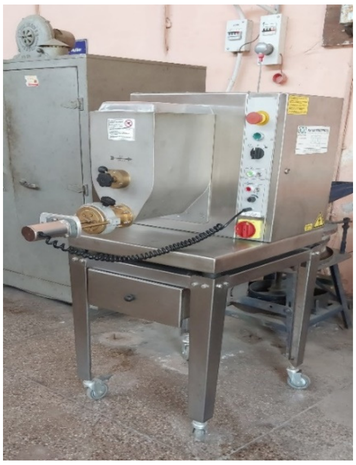


Plate 2 : Pasta Machine

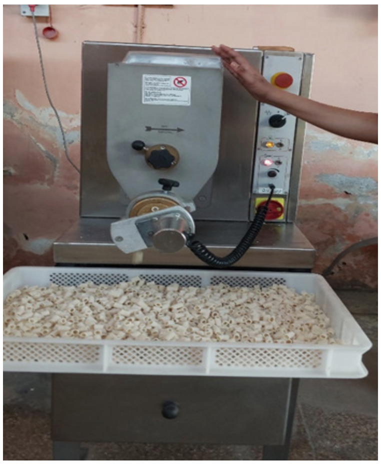


Plate 3 : Pasta Development

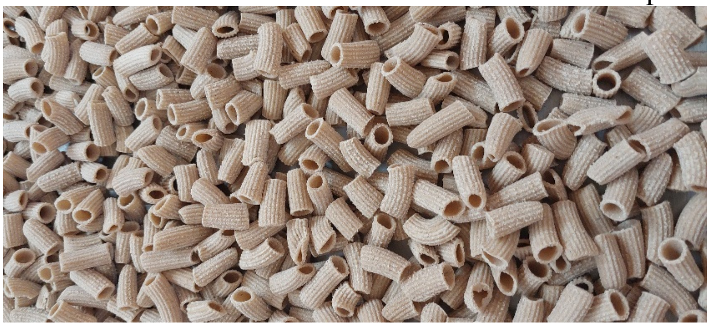


Plate 4 : Gluten Free Pasta

Table 1: Experimental Variable Parameters: As per the design for 4 x 5 matrix following table will be used for preparation of 30 different runs developed by RSM CCRD Design Experiment Model for the independent variables of pasta.

S. No.	Ingredients / Variables	Code	Code Levels				
			-2	-1	0	1	2
1	Blend% (SF:DSF:AF)	BR	60:10:30	60:15:25	60:20:20	60:25:15	60:30:10
2	Guar Gum %	GG	1	1.5	2	2.5	3
3	Drying Temperature (°C)	DT	50	55	60	65	70
4	Air Flow Rate (m/sec)	AF	1.0	1.25	1.5	1.75	2

SF – Sorghum flour, DSF – Defatted Soyflour, AF – Amaranth flour, Water – 35%, Oil – 2%, Salt – 1% were at their Fixed level.

Nutritional Properties Evaluation

The different composition of flour were assessed for the chemical properties such as protein content (AOAC, 1980), fat content, ash content, crude fiber, total carbohydrate, moisture content (AOAC, 2000).

Protein Content

The protein content in samples were determined by using conventional micro-Kjeldahl digestion and distillation procedure as given in AOAC (1980).

Fat Content

Fat content in pasta samples was estimated by standard method (AOAC, 2000) using the automatic SOCS plus Solvent extraction system.

Fibre Content

Crude fibre in pasta samples were estimated by the standard method of analysis (AOAC, 2000) using automatic Fibra-Plus apparatus.

Ash Content

Ash content in the pasta samples were estimated by employing the standard method of analysis (AOAC, 2000).

Carbohydrate Content

Carbohydrate content of foods for many years, has been calculated by difference, rather than analysed directly. Under this approach, the other constituents in the food (protein, fat, water, fibre, ash) are determined individually, summed and subtracted from the total weight of the food.

Moisture Content

The moisture content of the samples were estimated according to the method of AOAC (2000). The sample (5g) was taken in pre-weighed petridish, dried at 130°C for 3hr in hot air oven, cooled in desiccators and weighed. The difference in weight of petridish represents the moisture content of the sample.

Statistical Analysis

Response surface methodology (RSM) was utilised to appropriately analyse the data collected during the current study and optimise the different parameters.

Results and Discussion

1.1 Protein Content of Pasta

Proteins play a crucial role in biological functions and the structure of cells. The observed values of protein content of pasta with different combination of process and operational parameters are presented in Table 2. The protein content of all pasta samples measured in the experiment ranged from 14.74% to 21.27%. The highest protein content, 21.27%, was found in a sample with a blend ratio of 60:30:10, incorporating 2% guar gum, dried at 60°C, and an air flow rate of 1.5 m/sec. Conversely, the lowest protein content of 14.74% occurred in a pasta sample with a blend ratio of 60:10:30, also using 2% guar gum, at the same drying temperature and air flow rate.

The multiple regression analysis examining the protein content of pasta (PP) in relation to Blend Ratio (BR), Guar Gum (GG), Drying Temperature (DT), and Air Flow Rate (AFR) was conducted using a Central Composite Rotatable Design (CCRD). This analysis led to the fitting of a quadratic equation, which created a representative response surface for the data and resulted in the development of the following model.

Actual Equation for Protein content in Pasta

$$P.P. = 32.412 + 0.131 \times B.R. - 1.978 \times G.G. - 0.393 \times D.T. - 5.477 \times A.F.R. + 0.040 \times B.R. \times G.G. + 0.007 \times B.R. \times D.T. - 0.176 \times B.R. \times A.F.R. + 0.012 \times G.G. \times D.T. + 0.135 \times G.G. \times A.F.R. + 0.041 \times D.T. \times A.F.R. - 0.001 \times B.R.2 + 0.051 \times G.G2 + 0.001 \times D.T.2 + 1.905 \times A.F.R.2 \quad \text{..... Eq. (1.1)}$$

1.2 Fat Content of Pasta

The observed values of fat content of pasta with different combination of process and operational parameters are presented in Table 2. The fat content of pasta measured for all the pasta samples ranged from 1.41% to 2.65%. The fat content of pasta was maximum (2.65%) where, blend ratio of 60:20:20 with 3% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate. The fat content of pasta was minimum (1.41%) where, blend ratio of 60:25:15 with 2.5% guar gum at 55°C drying temperature and 1.75 m/sec of air flow rate and where blend ratio of 60:25:15 with 2.5% guar gum at 55°C drying temperature and 1.25 m/sec of air flow rate respectively.

Actual Equation for Fat content in Pasta

$$F.P. = -31.20 + 0.323 \times B.R. + 3.195 \times G.G. + 0.682 \times D.T. + 8.470 \times A.F.R. - 0.080 \times B.R. \times G.G. + 0.001 \times B.R. \times D.T. + 0.008 \times B.R. \times A.F.R. + 0.003 \times G.G. \times D.T. + 0.025 \times G.G. \times A.F.R. - 0.009 \times D.T. \times A.F.R. - 0.007 \times B.R.2 - 0.371 \times G.G2 - 0.006 \times D.T.2 - 2.685 \times A.F.R.2 \quad \text{...... Eq. (1.2)}$$

1.3 Fibre Content of Pasta

The observed values of fibre content of pasta with different combination of process and operational parameters are presented in Table 2. The fibre content of pasta measured for all the pasta samples ranged from 2.83% to 3.16%. The fibre content of pasta was maximum (3.16%) where, blend ratio of 60:15:25 with 2.5% guar gum at 65°C drying temperature and 1.75 m/sec of air flow rate. The fibre content of pasta was minimum (2.83%) where, blend ratio of 60:20:20 with 2% guar gum at 50°C drying temperature and 1.5 m/sec of air flow rate respectively.

Actual Equation for Fibre content in Pasta

$$Fb.P. = 0.194 + 0.006 \times B.R. - 0.063 \times G.G. + 0.099 \times D.T. - 0.357 \times A.F.R. - 0.003 \times B.R. \times G.G. - 0.009 \times B.R. \times A.F.R. + 0.004 \times G.G. \times D.T. + 0.105 \times G.G. \times A.F.R. - 0.004 \times D.T. \times A.F.R. - 0.049 \times G.G2 - 0.001 \times D.T.2 + 0.205 \times A.F.R.2 \quad \text{..... Eq. (1.3)}$$

1.4 Ash Content of Pasta

The observed values of ash content of pasta with different combination of process and operational parameters are presented in Table 2. The ash content of pasta measured for all the pasta samples ranged from 2.18% to 2.78%. The ash content of pasta was maximum (2.78%) where, blend ratio of 60:30:10 with 2% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate. The ash content of pasta was minimum (2.18%) where, blend ratio of 60:10:30 with 2% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate respectively.

Actual Equation for Ash content in Pasta

$$A.P. = 2.904 - 0.009 \times B.R. + 0.743 \times G.G. + 0.002 \times D.T. - 1.777 \times A.F.R. + 0.003 \times B.R. \times G.G. + 0.016 \times B.R. \times A.F.R. - 0.005 \times G.G. \times D.T. - 0.040 \times G.G. \times A.F.R. - 0.098 \times G.G2 + 0.490 \times A.F.R.2 \quad \text{...... Eq. (1.4)}$$

1.5 Carbohydrate Content of Pasta

The observed values of carbohydrate content of pasta with different combination of process and operational parameters are presented in Table 2. From the experiment the carbohydrate content measured for all the pasta samples ranged from 63.46% to 69.91%. The carbohydrate content of pasta was minimum (63.46%) where, blend ratio of 60:20:20 with 1% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate. The carbohydrate content of pasta was maximum (69.91%) where, blend ratio of 60:10:30 with 2% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate.

Actual Equation for Carbohydrate content in Pasta

C.P. = 134.822 - 0.680 × B.R. + 4.535 × G.G. – 1.941 × D.T. – 10.483 × A.F.R. + 0.034 × B.R. × G.G. - 0.013 × B.R. × D.T. + 0.186 × B.R. × A.F.R. - 0.011 × G.G. × D.T. + 0.810 × G.G. × A.F.R. - 0.004 × D.T. × A.F.R. + 0.021 × B.R.2 - 0.720 × G.G2 + 0.019 × D.T. 2 + 2.860 × A.F.R.2 **........ Eq. (1.5)**

1.6 Moisture Content of Pasta

The observed values of moisture content of pasta with different combination of process and operational parameters are presented in Table 2. From the experiment the moisture content measured for all the pasta samples ranged from 7.04% to 9.34%. The moisture content of pasta was minimum (7.04%) where, blend ratio of 60:30:10 with 2% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate. The moisture content of pasta was maximum (9.34%) where, blend ratio of 60:20:20 with 1% guar gum at 60°C drying temperature and 1.5 m/sec of air flow rate.

Actual Equation for Moisture content in Pasta

M.P. = -35.247 + 0.250 × B.R. + 0.155 × G.G. +1.307 × D.T. + 4.623 × A.F.R. + 0.099 × B.R. × G.G. +0.004 × B.R. × D.T. - 0.147 × B.R. × A.F.R. - 0.042 × G.G. × D.T. - 0.890 × G.G. × A.F.R. + 0.068 × D.T. × A.F.R. - 0.012 × B.R.2 + 0.377 × G.G2 - 0.012 × D.T. 2 – 1.433 × A.F.R.2 **........ Eq. (1.6)**

Table 2: ANOVA for chemical composition of pasta developed from the blends of sorghum flour, defatted soyflour and amaranth flour.

Source	**Protein**	**Fat**	**Fibre**	Ash	**Carbohydrate**	**Moisture**
Model SS	69.26	3.45	0.190	0.759	64.17	9.36
Model MS	4.95	0.246	0.014	0.054	4.58	0.669
Model DF	14	14	14	14	14	14
F Value	48.40	6.26	5.22	17.09	15.64	9.61
P Value	0.0001	0.0005	0.0015	0.0001	0.0001	0.0001
R Square %	0.978	0.854	0.829	0.941	0.936	0.899
Std. Dev.	0.319	0.198	0.051	0.056	0.541	0.264
Mean	18.41	1.88	3.00	2.51	65.89	8.26
C.V.%	1.74	10.56	1.70	2.24	0.822	3.19

Assessment of Nutritional Properties

The moisture content (%) of different combination of fortified flour and ingredients was ranging from 7.04% to 9.34% with the mean value of 8.26. The observations from the protein content (%) analysis indicated that the crude protein ranges from 14.74% to 21.27% with the average value of 18.41. As expected, the pasta fortified with maximum percentage of defatted soyflour found to have increased level of protein content as compared to pasta with blends having maximum amaranth flour percentage. The fat content (%) ranged from 1.41% to 2.65% exhibit the mean value of 1.88. The observations from ash content (%) ranges from 2.18% to 2.78% with the mean value of 2.51. The crude fiber content analysis indicated that the fiber content (%) ranges from 2.83% to 3.16% with the mean value of 3.00. It is observed that the fiber content in pasta were increased with blends having maximum amount of amaranth flour as compared to blends with defatted soyflour. The total carbohydrate observations indicated that the carbohydrate (%) ranges from 63.46% to 69.91% with the mean value of 65.89. Results shows that with regards to the flour blends of (SF:DSF:AF) sorghum, defatted soy and amaranth fortified pasta, the protein, fibre, ash content increases with increasing level of defatted soyflour whereas, the fat, carbohydrate and moisture content decreases with increasing level of defatted soyflour on pasta samples. The increase in drying temperature and airflow rate levels increases the moisture content in pasta samples. The best pasta samples were obtained at optimal conditions (blend ratio 60:20:20, guar gum 2%, drying temperature 60°C and airflow rate 1.5 m/sec).

Conclusion

Among all the nutritional properties of pasta developed from the blends of sorghum, defatted soy and amaranth flour, the samples obtained at optimal conditions (blend ratio 60:20:20, guar gum 2%, drying temperature 60°C and airflow rate 1.5 m/sec) was found to be best among all the combinations.

Application of research

The gluten free pasta is a good alternative for shift in structure of diet in the hectic lifestyle. The supplementation of defatted soyflour and amaranth flour with the millet i.e. sorghum flour in pasta making leads to protein enriched diet and overcome the problem of celiac disease.

References

Andhale, R.R., Katkade, M.B., Dagadkhair, A.C., Dagadkhair, R.A. and Jadhav, A.A (2019). Impact of Different Levels of Guar Gum on Quality and Texture Profile (TAXT-2 Texture Analyser) of Noodles Fortified with Pearl Millet Flour. *Journal of Emerging Technologies and Innovative Research*, 6(5) (122-128).

Ansari, A., Kalbasi-Ashtari and Gerami, A. (2013). Effects of Defatted Soy Flour, Xanthan Gum, and Processing Temperatures on Quality Criteria of Spaghetti. *J. Agr. Sci. Tech.,* **15**, 265-278.

AOAC (1980). Association of Official Analytical Chemists. 16th edn. Arlington; c1980.

AOAC (2000) Association of Official Analytical Chemists. Official Methods of Analysis. Vol. II, 17th Edition, AOAC, Washington DC.

Bergman, C., Gualberto, D., Weber, C. (1994). Development of high-temperature dried soft wheat pasta supplemented with cowpea (*Vigna unguiculata* (L.) Walp). Cooking quality, color, and sensory evaluation. *Cereal Chemistry*, **71**(6), 523–727.

Bouasla, A. and Wojtowicz, A. (2019). Rice-Buckwheat Gluten-Free Pasta, Effect of Processing Parameters on Quality Characteristics and Optimization of Extrusion-Cooking Process. Foods, **8**, 496. Page. (1-16)

Jatav, A.K., Bhatt, D.K. and Kiledar, S. (2016). Development and Quality Evaluation of Amaranth Flour Pasta. *Asian Journal of Pharmaceutical Education and Research*, **5**(2), 1-11.

Kaushik, J.S., Narang, M. and Parakh, A. (2011). Fast food consumption in children. *Indian Pediatrics,* **48**(2), 97-101.

Serrem, C., Kock, H. and Taylor, J. (2011). Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soy flour. *Int. J. Food Sci. Technol*., **46**(1), 74-83.

Tomar, A.K., Shrivastava, A., Parihar, P., Shukla, S.S. and Thakur, R.S. (2022). Evaluation of Physiochemical And Sensory properties of Maize Fortified Pasta. *International Journal of Agriculture Sciences*, **14**(12), 12101-12104.

Tomar, A.K., Shrivastava, A., Parihar, P., Shukla, S.S. and Thakur, R.S. (2023). Development and evaluation sorghum fortified pasta using response surface technology. *The Pharma Innovation Journal,* **12**(2), 2681-2685.