Your full article (between 500 to 5000 words) - - Do check for grammatical errors or spelling mistakes

EVALUATION OF MULTI**CEREALS** ENRICHED EXTRUDED MACARONI PASTA

Jarupla Surendar, Srinivas.D, and **A**mala.B. **,**S.K Sadawarte

College of Food Technology

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MH)
Email: jarpulasurendar27@gmail.com

ABSTRACT

Extrusion is a process by which a set of mixed ingredients are forced through an opening in a perforated plate or die with a design specific to the food, and is then cut to a specified size by blades. The composite flours for the preparation of extruded macaroni pasta were prepared by blending of Barley, Maize, Sorghum and mixed flour in different proportions on dry weight basis *i.e.* A (50:10:10:30), B (50:15:15:20) and C (50:20:20:10). The control flour was prepared by using Chickpea and rice flour (50:50). The moisture content of all the flours remained more or less similar with the values ranging from 9.75 to 11.39 per cent. The protein content of sorghum flour, chickpea flour, maize flour and rice flour was found to be 40.73, 17.25, 13.70 and 7.53 per cent respectively. Crude fiber content of chickpea, maize, sorghum and rice flour was found to be 3.91, 3.57, 3.25 and 0.34 per cent respectively. The physicochemical characteristics of extruded cookies were determined by standard methods. The cost of production of extruded cookies food 1kg was found to be Rs. 108.25. The product sample A scored significantly and it is commercially feasible and can be exploited in the market.

Key words: *Extruded **macaroni pasta**, barley, maize, sorghum, rice*

INTRODUCTION

India holds the second-largest agricultural land (179.9 million hectares) in the world. Food grain production covers dominant part of the cropped area (65%) in Indian agriculture. According to the Food and Agricultural Organization (FAO), India is the world's largest producer of millets and second-largest producer of wheat, rice and pulses. Indian Basmati rice is traditionally grown in Punjab, Haryana, and western Uttar Pradesh. With the introduction of high-yielding PUSA-1121 variety, India's long-grain basmati rice production has been improving, and its cultivation has spread to other parts of Uttar Pradesh and Madhya Pradesh.

Extrusion is a process used to create objects of a fixed cross-sectional profile. A material is pushed through a die of the desired cross-section. The two main advantages of this process over other manufacturing processes are its ability to create very complex cross-sections, and to work materials that are brittle, because the material only encounters compressive and shear stresses. It also forms parts with an excellent surface finish.[1]

Drawing is a similar process, which uses the tensile strength of the material to pull it through the die. This limits the amount of change which can be performed in one step, so it is limited to simpler shapes, and multiple stages are usually needed. Drawing is the main way to produce wire. Metal bar and tube are also often drawn.

Extrusion may be continuous (theoretically producing indefinitely long material) or semi-continuous (producing many pieces). The extrusion process can be done with the material hot or cold. Commonly extruded materials include metals, polymers, ceramics, concrete, play dough, and foodstuffs. The products of extrusion are generally called "extrudates".

Hollow cavities within extruded material cannot be produced using a simple flat extrusion die, because there would be no way to support the centre barrier of the die. Instead, the die assumes the shape of a block with depth, beginning first with a shape profile that supports the center section. The die shape then internally changes along its length into the final shape, with the suspended center pieces supported from the back of the die. The material flows around the supports and fuses together to create the desired closed shape.The extrusion process in metals may also increase the strength of the material.

Spices the term ‘spice’ is used to refer to all of the edible parts of a plant used for flavouring foods, including roots, stems, seeds, rhizomes and the leafy plant parts usually referred to as herbs. Spices are the building blocks of flavours, they create the desired taste and characterise cuisines. A food developer needs technical knowledge, creative talent, and an understanding of the cultural aspects of the consumer in order to develop successful products (Susheela, 2003).

METHODOLOGY

Preparation of blend and mixing

Composite of products was prepared by mixing barley flour, maize flour sorghum flour and rice flour in the different ratios shown in the Table 1. These blends were chosen according to

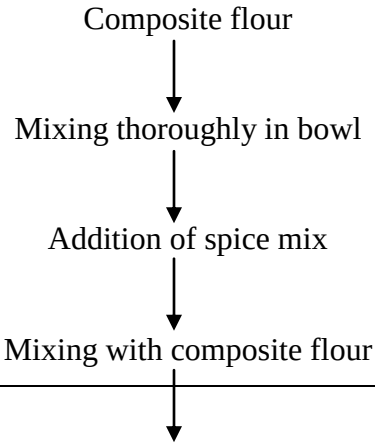
preliminary tests without jamming of extruder and for acceptable product's physical characteristics as well as better nutritive value in the final product. The blended samples were conditioned to 21% - 22% moisture by spraying with a calculated amount of water and mixing continuously at medium speed in a blender. The samples were put in buckets and stored at 4˚C overnight. The feed material was then allowed to stay for 3 h to equilibrate at room temperature prior to extrusion.

Table 1: **Formulation of different composite flour**

Sr. No.	**Flour**	**Composition of Composite flour**			
		Control	**A**	**B**	**C**
1	maize flour	50	50	50	50
2	Maize flour	---	10	15	20
3	Sorghum flour	---	10	15	20
4	Rice flour	50	30	20	10

Method for preparation of Extruded product

The production of extruded macaroni pasta was started by dry mixing the composite flour in a bowl. Then the spice mix and other dry ingredients were added and mixed thoroughly. The mixture was kneaded in the bowl and dough was formed with using enough water added. Then, the dough was placed into hand mold before pressing it into hot oil and deep frying it at 180°C to 200°C until the product turns golden brown color. After frying, the products were kept in an airtight container to prevent it from deteriorate by moisture or other elements that may cause unacceptable taste and reduce crispiness.



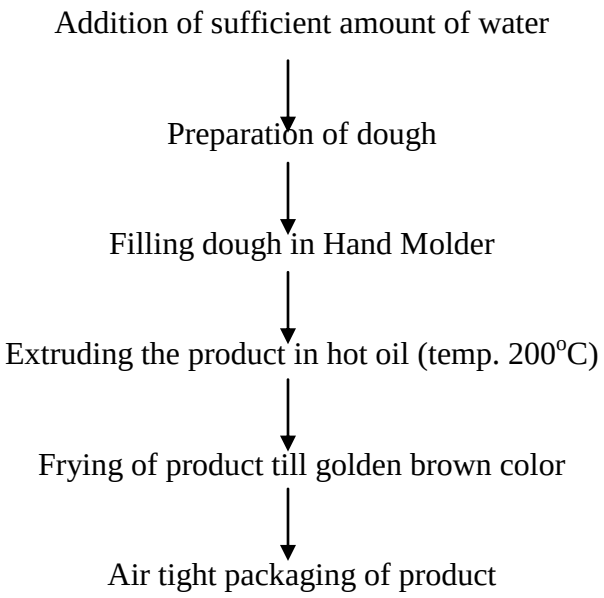


Fig 1: Preparation of extruded macaroni pasta

Chemical Composition

Moisture, ash, fat, carbohydrate, protein and measured by using standard methods described by (AOAC, 2002: AOAC, 2005)

Functional Properties

The dried samples were analyzed for the density of extrudates (including: tap density, true density and bulk density, water absorption index and water solubility index).

Organoleptic Evaluation

The product were evaluated for its acceptability based on sensory parameters like flavour, texture, color and overall acceptability using nine-point hedonic scale (1 = dislike extremely to 9 = like extremely).

Statistical Analysis

The analysis of variance of the data obtained was done by using Completely Randomized Design (CRD) for different treatments as per the methods given by (Panse and Sukhatme, 1985). The analysis of variance revealed at significance of $P < 0.05$ level, S.E. and C.D. at 5 % level is mentioned wherever required.

RESULTS

Proximate composition of Rice flour, Maize flour, Sorghum flour and chickpea flour

Chemical composition different namely moisture content, macronutrients contents (such as protein, fat and carbohydrates), ash and crude fiber of different flour are presented in the Table 2.

It could be observed from the table that moisture content of all the flours remained more or less similar with the values ranging from 9.75 to 11.39 per cent. Amongst all the ingredients, sorghum flour were found to contain highest amount of fat (i.e. 19.75%) while the lowest fat content was observed in rice flour (1.21 per cent). With respect to protein, the protein content of sorghum flour, chickpea flour, maize flour and rice flour was found to be 40.73, 17.25, 13.70 and 7.53 per cent respectively.

Crude fiber content of chickpea, maize, sorghum and rice was found to be 3.91, 3.57, 3.25 and 0.34 per cent respectively. The high amount of carbohydrate was found in rice flour (77.2%) followed by maize flour (62.73%), barley flour (6056%) and lowest in sorghum flour (22.51%).

Table 2: Proximate composition of rice flour, maize flour, sorghum flour and rice flour

Flour	Moisture (%)	Crude Fat (%)	Crude Protein (%)	Ash (%)	Crude Fiber (%)	Carbohydrate (%)
Rice flour	11.39	1.21	7.53	1.01	0.34	77.2
Maize flour	10.70	7.50	13.70	1.75	3.57	62.73
Sorghum flour	9.75	19.75	40.73	4.19	3.25	22.51
Chickpea Flour	9.81	5.38	17.25	1.65	3.91	60.56

* Each value represents the average of three determinations

The results with respect to the composition of sorghum flour are comparable with the earlier reported values (Pollock and Geddes, 1960). Nearly similar values for rice (Ding *et al.*,

2005), chickpea (Gopalan *et al.*, 2006) and maize flour (Hahn *et al.*, 1990) were reported earlier.

Functional properties of extruded cookies

The functional properties of extruded cookies are presented in the Table 3.

The mass flow rate gives an indication of soundness of ingredient to pass through the dies in preparation of extruded product. The results during present investigation revealed that rate of increase in sorghum flour and maize flour concentration linearly increased the Mass flow rate (MFR). The mass flow rate was found to be higher in sample C (3.30) and lowest in control sample (3.22).

Tap density and bulk density of control, sample A, B and C were observed as 0.34, 0.33, 0.31, 0.30 and 0.14, 0.13, 0.11, 0.10 respectively. Tap density of the product was found to be linearly decreasing with increasing concentration of soy and maize flour. This may be due to the highest density of flours and the lower rate of expansion which resulted into such values

The Water Solubility Index (WSI) is related to the quantity of water soluble molecules, and is associated to dextrinization. Finding showed that WSI of sample C (0.36) was higher followed by B (0.35 %), A (0.31 %) and control (0.28 %). Similar trends were reported by Anderson *et al.* (1969). Analysis of data showed that WHC in extruded macaroni pasta sample C was higher (440) while lowest in sample A (396). Water holding capacity is function of protein content. The increase in protein content results into higher entrapment of moisture in the protein matrix resulting into increased WHC of product. Similar results were reported by Shirani and Ganeshranee (2009). The moisture retention and expansion ratio of extruded macaroni pasta for control, sample A, B and C were found to be 25.73, 25.71, 25.69, 25.68 and 1.61, 1.68, 1.83 and 1.91 respectively. Moisture retention capacity also found to slightly increase with increase in concentration of sorghum and maize flour which is found to be insignificant. The consumer acceptability of product could also be correlated with expansion ratio.

Table 3: Functional properties of extruded macaroni pasta

Parameters	Samples				S.E±	C.D at 5% level
	Control	A	B	C		
Mass flow rate (g/s)	3.22	3.25	3.27	3.30	0.014	0.04
Tap density	0.34	0.33	0.31	0.30	0.008	0.02

Bulk density	0.14	0.13	0.11	0.10	0.008	0.02
Water Solubility Index (%)	0.28	0.31	0.35	0.36	0.015	0.04
Water Holding Capacity	432	396	410	440	13.22	0.39
Moisture Retention	25.73	25.71	25.69	25.68	0.008	0.02
Expansion Ratio	1.61	1.68	1.83	1.91	0.068	0.206
Oil Absorption Capacity (%)	4.28	5.17	5.32	5.49	0.094	0.282

*Each value was an average of three determinations

In present investigation, it was revealed that expansion ratio increases with increase in concentration of sorghum and maize flour. This may be due to increase protein content and lowered starch content of product. Similar findings were reported by Sing *et al.* (1996).

The oil Absorption Capacity of cookies 4.28%, 5.17%, 5.32% and 5.49% were observed. Oil absorption capacity of product is found to increase with increasing concentration of sorghum and maize flour. The oil absorption capacity is the function of crude fibre content of product, which could be successfully correlated with the results obtained by Deshpande and Poshadri, 2011.

Nutritional composition of extruded macaroni pasta

In the present investigation, the efforts were made to enhance the nutritional quality of extruded macaroni pasta food by using sorghum and maize flour in replacement of rice flour. The nutritional composition of all the samples with control was analyzed and the results are reported in Table 4.

The results revealed that moisture content of control was found lowest while increase in concentration of soy and maize flour linearly increased the moisture content of product. The carbohydrate content was drastically reduced from 72.12 per cent for control to 54.51 per cent for Sample C. With respect to protein content, it could be clearly observed that the protein content of sample increase from 12.91 per cent to 20.49 per cent which is significantly high justifying the suitability of sorghum and maize flour incorporation in the product. The values of crude fiber content almost tripled from control to sample C. Fat content of sample also increased from 6.1 to 11.29 per cent.

Table 4: Nutritional composition of extruded macaroni pasta

Nutrient Parameters	Composition of Sample			
	Control	Sample-A	Sample-B	Sample-C
Moisture (%)	6.51	6.57	6.61	6.69
Carbohydrate (%)	72.13	64.01	59.33	54.11
Crude Protein (%)	12.91	16.3	18.15	20.49
Crude fat (%)	6.1	8.01	10.16	11.29
Calorific value kcal/100 g	395.06	413.82	437.36	400.01
Crude Fiber (%)	1.18	2.59	3.02	3.31
Ash (%)	1.02	1.57	1.72	2.09

However, it could be concluded that incorporation of soy and maize flour in extruded product resulted in increase in moisture, protein, fat, crude fiber and ash content while decreased the total carbohydrate content. Similar trends were reported by Guria, (2006).

Sensory evaluation of extruded products

The panel of semi-trained judges consisting of 10 members was given the extruded macaroni pasta food samples for evaluation of organoleptic characteristics *viz*. color, taste, flavor, texture and overall acceptability. It was served to judges on the day of preparation.

Table 5: Organoleptic evaluation of extruded macaroni pasta food

Sample	Color	Flavor	Taste	Texture	Overall acceptability
Control	9.00	8.50	8.0	8.50	8.50
A	8.30	8.40	8.30	8.30	8.30
B	8.00	8.20	8.00	8.00	8.00
C	7.50	7.00	7.50	7.00	7.50

*Each value is average of ten determinations

The average score recorded by judges was considered presented and discussed (Table 5) under suitable quality attributes.

It may be visualized from Table 5, that the color of control sample was more acceptable

(9.00) followed by samples A (8.50), B (8.00) and C (7.50). The flavor character was more acceptable for sample A (8.40) as compared with Sample B (8.20). Further Control (8.50) sample was rated superior than sample C (7.00) as well as sample A (8.40). The best taste was observed in case of sample A (8.30), whereas Control sample and sample B scored same *i.e.* 8.00. It is important to note from the findings, Sample A was found better taste characteristics among other three samples. It can be observed that, the flours combinations in composite flour exhibited wide differences with regard to texture character of final product ranging from 7.00 to 8.50. The best texture was found for Control sample followed by sample A, B and C. The overall acceptability of extruded macaroni pasta food could be attributed to the different characters of colour, taste, flavour and texture of the final product. Highest score of overall acceptability was found for control while lowest for sample C.

CONCLUSION

From the present investigation, it could be concluded that the extruded sample –A (Chickpea; Maize; Sorghum; Rice; in the ratios of 50:10:10:30) was found to be having better sensorial quality than sample B and C. The chemical composition of the extruded products indicated that it has better nutritive value than commercial extruded products. The chemical composition of extruded sample A revealed that, it contains more protein (16.3g/100g), crude fiber (2.59g/100g) than that of commercial extruded products. This may be attributed to large quantity of Chickpea and Maize flour in the composite flour sample.

REFERENCES

Anderson R.A. (1982). Water absorption and solubility and amyl graph characteristics of roll-cooked small grain products. Cereal Chemistry, 59, 265-269.

AOAC (2002). Official Methods of Analysis of the AOAC International, 16th ed., 5th rev. Method 930.15. The Association, Gaithersburg, MD.

AOAC (2005). Official Methods of Analysis of the AOAC International, 18th ed. Association of Official Analytical Chemists, Gaithersburg, MD.

Colonna P., Tayeb J. and Mercier C. (1989). Extrusion cooking of starch and starchy products. In: Mercier, C., Linko, C.P. and Harper, J.M., Eds., Extrusion Cooking, American Association of Cereal Chemists, Inc., St. Paul, 247-319.

Deshpande H. and Poshadri A. (2011). Physical and sensory characteristics of extruded cookies

prepared from Foxtail millet based composite flours International Food Research Journal, 18, 751-756.

Ding Q., Ainsworth B., Plonkell A., Tucker G. and Marson H. (2005). The effect of extrusion conditions on the physicochemical properties and sensory characteristics of rice-based expanded cookies. Journal of Food Engineering, 66, 283-289.

Gopalan C.R., Sastri B.V. and Subramanian B. (2006). Nutritive value of Indian foods, published by National Institute of Nutrition, ICMR, Hyderabad. 47- 69.

Guria P. (2006). Physico-chemical properties, nutritional quality and value addition to quality protein maize (*Zea mays*). Department of Food Science and Nutrition, College of Rural Homescience, University of Agricultural Sciences, Dharwad.

Hahn J.D., Chung T.K. and Baker D.H. (1990). Nutritive value of maize flour and maize bran. J Anim Sci. 68, 4253-4260.

Kadan R.S., Bryant R.J. and Pepperman A.B. (2003). Functional properties of extruded rice flours. Journal of Food Science, 68, 1669-1672.

Li S., Zhang H.Q., Jin Z.T. and Hsieh F. (2005). Textural modification of soya bean/corn extrudates as affected by moisture content, screw speed and soya bean concentration. International Journal of Food Science and Technology, 40, 731-741.

Mahungu S.M., Diaz-Mercado S., Li J., Schwenk M., Singletary K. and Faller J. (1999). Stability of isoflavones during extrusion processing of corn/soy mixture. Journal of Agriculture and Food Chemistry, 47, 279-284.

Panse V.G. and Sukhatme P.V. (1985). Statistical methods for agricultural workers ICAR pub. Ed^{n}. New Delhi.

Pollock J.M. and Geddes W.F. (1960). Soya flour as white ingredients, paper no.4180 scientific journal series, Minnesota agricultural experiment station the Procter and gamble co., Cincinnati, Ohio.

Riaz M.N. (1999). Sorghum as functional food. Cereal Food World., 44(2), 88-92.

Shirani G. and Ravindran G. (2009). Extruded products with fenugreek (*trigonella- graecium*) barley and rice: physical properties, sensory acceptability and glycemic index, Journal of Food Engg., 90, 45-52.

Singh N., Singh B., Sandhu K.S., Bawa A.S. and Sekhon K.S. (1996). Extrusion behavior of wheat, rice and potato blends, J Food Sci Technol, 33(4), 291-294.

Singh S., Gamlath S. and Wakeling L. (2007). Nutritional aspects of food extrusion: A Review. International Journal of Food Science and Technology, 42, 916-929.

Zhou1 Z., Robards K., Helliwell S. and Blanchard C. (2002). Composition and functional properties of rice. International Journal of Food Science and Technology, 37, 849–868.

References (if any)

1.
2.

Terms - Do not remove or change this section (It should be emailed back to us as is)