www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(8): 489-493

www.thepharmajournal.com
Received: 08-05-2023
Accepted: 11-06-2023

Kuldeep Naghera
Department of Processing and Food Engineering, Junagadh Agricultural University, Junagadh, Gujarat, India

Mukesh Dabhi
Department of Processing and Food Engineering, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
Kuldeep Naghera
Department of Processing and Food Engineering, Junagadh Agricultural University, Junagadh, Gujarat, India

Standardization of flour proportion for pearl millet and chick pea based extruded product: A sensory evaluation approach

Kuldeep Naghera and Mukesh Dabhi

Abstract
Pearl millet, despite its excellent nutrition profile and agronomic traits, has not gained widespread popularity compared to other cereals worldwide. To overcome the limited availability of millets and transfer their health benefits to distant places, the development of globally acceptable food products is essential. The use of a twin-screw extruder allows for precise control over the extrusion process parameters, ensuring uniform product quality. The experiments are conducted under controlled independent parameters, including a die temperature of 120 °C, screw speed of 275 rpm, and moisture content of 16% w.b. Sensory evaluation is performed to assess the organoleptic attributes of the extruded products. The study investigates six different flour compositions; 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50 (pearl millet flour: chickpea flour). The sensory evaluation is conducted to assess chewiness, hardness, taste, colour, and overall acceptability of the extruded products. A trained sensory panel is employed to evaluate the extruded products based on the selected parameters. Chewiness and hardness are evaluated to measure the texture and mouthfeel of the products. Taste evaluation is conducted to assess the flavor characteristics and palatability. Colour analysis is performed to determine the visual appeal of the products. The panelists provide scores for each attribute using a 9-point hedonic scale, enabling a comparative analysis of the different flour compositions. Based on the sensory evaluation, the composition 70% pearl millet flour and 30% chickpea flour yielded the highest sensory scores and can be considered suitable for the production of extruded products.

Keywords: Pearl millet, extrusion, chickpea, sensory, 9-point hedonic scale

1. Introduction

Millets, belonging to the Poaceae family, are small-seeded grains that have gained recognition as a crop of food security due to their resilience in adverse agro-climatic conditions (Ushakumari *et al*., 2004) [16]. Millets have a long history of cultivation, with evidence of pearl millet cultivation dating back to 2500 BC in Mali and its presence in South Asia as early as 2300 BC. Pearl millet (*Pennisetum glaucum* L.) is one of the oldest cereals consumed worldwide as a staple food, particularly in hot and dry regions where other crops like wheat and maize struggle to thrive (Deepak *et al*., 2012) [6]. In India, pearl millet holds the distinction of being the fourth most widely cultivated food crop, following rice, wheat, and maize. The major pearl millet-growing states, namely Rajasthan (which has the highest production), Uttar Pradesh, Gujarat, Haryana, and Maharashtra, contribute to 90% of the total production in the country. Pearl millet is often referred to as the "poor man's food" due to its extensive utilization by the economically weaker sections of the population (Reddy *et al*., 2018) [13].

Chickpea (*Cicer arietinum* L.) stands out as the most important rabi season crop, with wide acceptability and extensive use in the nutritional food basket. India takes the lead as the largest producer of chickpeas globally, accounting for 65% of the total area and 77% of total production. Chickpeas represent a significant proportion, 88% (8.42 million hectares), of the total pulse area and 49% (8.47 million tonnes) of total pulse production in India. The major chickpea-producing states include Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Maharashtra, Punjab, Himachal Pradesh, and Bihar. In Gujarat, the regions of Bhal (Kheda, Ahmedabad, Bhavnagar, and Surendranagar districts) and Ghed (Junagadh and Porbandar districts) serve as the main cultivation areas for chickpeas (Anon., 2020) [1].

Extrusion cooking has revolutionized the production of snack foods and has become an important method for producing low-cost nutritious food products. Consumers nowadays are becoming more and more conscious about concept of convenient and hygienic snacks. Extrudates are one of the major growing commodities in snack foods.

Nowadays, children and even adults have started liking and consuming extrudates (Gojiya *et al*., 2022) [8]. This high-temperature short-time (HTST) processing technology offers several advantages over other cooking processes. One of the key advantages is the better retention of nutrients during the extrusion process compared to traditional cooking methods, primarily due to the shorter processing time involved. Extruders, the machines used for extrusion cooking, offer various benefits such as lower operating costs, higher productivity, versatility, and energy efficiency (Thilagavathi *et al*., 2015) [15].

Sensory evaluation is a scientific approach used to assess and analyze the sensory properties of products, such as food, beverages, cosmetics, fragrances, and more. It involves the systematic use of human senses, including sight, smell, taste, touch, and sometimes hearing, to evaluate and understand the characteristics of a product. It is important to design sensory evaluation studies carefully, considering factors such as sample preparation, panelist selection, sensory testing environment, and statistical analysis methods. By employing these various approaches, sensory evaluation provides valuable data and insights that help in product development, quality control, and consumer satisfaction (Stone *et al*., 2020) [14].

The changing lifestyle of consumers has led to a demand for convenient and time-saving food products. Ready-to-eat products provide this convenience by saving time, reducing labour, and offering hygienic products with extended shelf life. However, the limitation lies in the protein content and quality of these products. To overcome this limitation and meet consumer demands, food processing industries have been incorporating novel ingredients such as chick pea into food products to enhance their nutritive and functional properties.

2. Materials and Methods

2.1 Raw materials

The pearl millet and chick pea grains required for the research work was obtained from the local market of Junagadh city. The grains were cleaned manually to remove all impurities and then coarse grinded using stone mill. The flour was then sieved to obtain uniform particle size flour.

2.2 Composite flour preparation

The extruded products using pearl millet flour and chickpea flour were prepared at different proportions. The flour of chickpeas was varied from 0 to 50% and the remaining part was contented by pearl millet (Table 1).

Table 1: Proportion of pearl millet flour and chickpea flour to be used

Feed composition	Pearl millet (%)	Chickpea (%)	Total quantity
T_1	100	0	100
T_2	90	10	100
T_3	80	20	100
T_4	70	30	100
T_5	60	40	100
T_6	50	50	100

2.3 Proximate composition of raw materials

The biochemical characteristics viz. moisture content, total carbohydrate, true protein, crude fibre, starch, total ash, calcium, iron and zinc content of the flours were determined as per the standard procedures. Moisture content was determined by oven drying method according to AOAC (2012a) [4]. Carbohydrate content of the prepared flour was determined by Phenol Sulphuric acid method (Dubois *et al*. 1956) [7]. True protein content of composite flour was determined by Folin-Lowry method as described by Lowry's methods (Lowry *et al.* 1951) [10]. Crude fibre is the organic residue that remains after the food sample has been treated under boiling dilute sulphuric acid, boiling dilute sodium hydroxide solution and alcohol (AOAC, 2005b) [5]. Estimation of starch content of the prepared composite flour was determined by anthrone reagent method as described in (Hodge and Hofreiter, 1962) [9]. Total ash content was determined using muffle furnace as described by AOAC (2005a) [4] Calcium, iron and zinc content of composite flour samples were determined by MP-AES diacid digestion method AOAC (2012b) [5].

2.4 Development of Extruded Products

The laboratory co-rotating twin-screw extruder (Basic Technology Pvt. Ltd., Kolkata, India) was used to develop extruded products. Prior to use the extruder, it was kept in the running condition without feeding the material. It is necessary for removal of residual material deposited in the extruder. The die temperature and screw speed were set as per the requirement on the control panel. The parameters; die temperature, screw speed, and moisture content was set at 120 °C, 275 rpm, and 16% w.b., respectively. The die diameter was selected as 3 mm as recommended by the manufacturer for type of the product developed. The moisture was added to the flour mixture as per the treatment combinations. A 300 gram of flour mixture prepared from pearl millet and chick pea flour was fed to the extruder. The cutter speed was kept near 120 rpm. The extruded product coming out of die was collected in a tray and dried for 1 hour to reduce moisture content from product. The product was then packed in zipped lock plastic bags and stored at room temperature for future analysis.

2.5 Sensory Evaluation

The 9-point hedonic scale sensory method as given by (Ranganna, 1986) [12] was used to examine developed extrudates. The parameters included chewiness, hardness, taste, colour and overall acceptability (OA) and were tested with 9-point hedonic scale ranging from dislike extremely to like extremely. This score provides an overall measure of consumer preference and acceptance of the extruded product. The product attained average score above 5 was considered as a satisfactory (Nikmaram *et al*., 2015) [11].

3. Results and Discussion

3.1 Proximate Composition of Raw Materials

The biochemical characteristics of the pearl millet and chick pea flour selected for the study are presented in the Table 2. The moisture content, carbohydrate, protein, crude fibre, starch, total ash, calcium, iron and zinc content were determine as given.

Table 2: Biochemical analysis of pearl millet and chick pea flour

Sr. No.	Parameters	Pearl millet flour	Chick pea flour
1.	Moisture content (% w.b.)	9.18	9.06
2.	Total carbohydrate (%)	77.40	58.10
3.	True protein (%)	7.43	17.31
4.	Crude fibre (%)	3.17	4.16
5.	Starch (%)	74.09	30.12
6.	Total ash (%)	1.32	2.59
7.	Calcium (ppm)	197.81	535.91
8.	Iron (ppm)	61.17	52.43
9.	Zinc (ppm)	31.34	34.95

3.2 Proximate Composition of the Composite Flour

The biochemical characteristics of the composite flour prepared by mixing of pearl millet flour and chick pea flour selected for the study were presented in the Table 3. Total five compositions of the composite flour (pearl millet flour: chick pea flour) were there in the study, i.e., 90:10, 80:20, 70:30, 60:40 and 50:50.

Table 3: Biochemical analysis of pearl millet flour

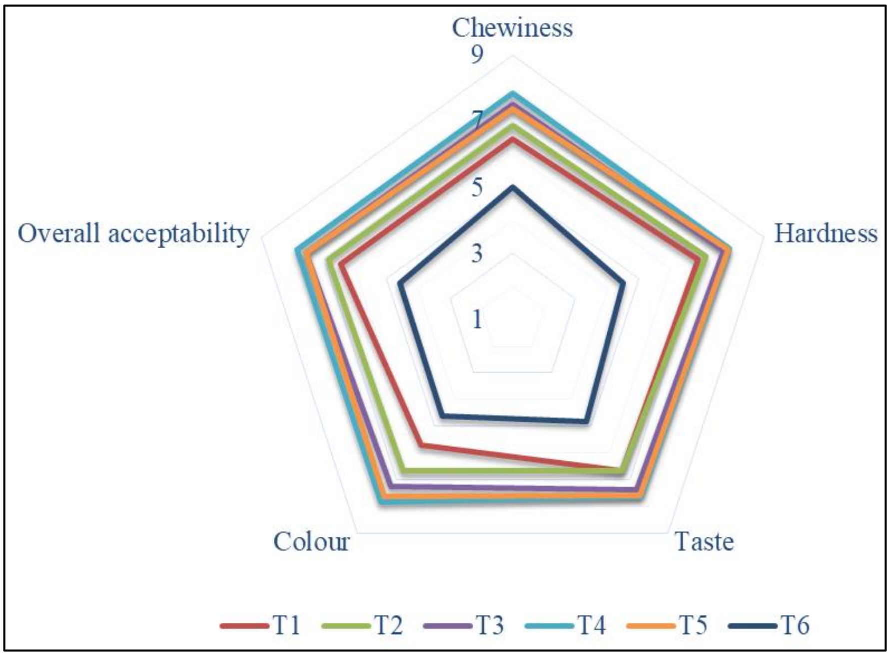
Sr. No.	Parameters	Pearl millet flour: Chick pea flour				
		90:10	80:20	70:30	60:40	50:50
		Average values				
1.	Moisture content (% w.b.)	9.19	9.05	8.37	9.07	8.86
2.	Total carbohydrate (%)	77.49	75.24	73.57	71.31	68.75
3.	True protein (%)	11.89	11.58	13.05	12.43	12.34
4.	Crude fibre (%)	3.71	3.85	4.98	5.07	5.16
5.	Starch (%)	73.74	66.57	61.27	52.95	45.29
6.	Total ash (%)	1.78	1.92	1.94	2.34	2.01
7.	Calcium (ppm)	277.27	283.52	299.56	278.26	286.35
8.	Iron (ppm)	61.42	61.37	61.42	59.87	58.98
9.	Zinc (ppm)	30.28	30.98	31.53	32.78	33.47

3.3 Standardization of Flour Proportion

The extruded products using pearl millet flour and chickpea flour were prepared at different proportions. Experiment conducted six (6) trial runs to fix the feed composition (Table: 1). These prepared extruded products were analysed for sensory evaluation (Table: 4).

Table 4: Sensory evaluation of extruded product (Average value of panelists)

Treatment No.	Chewiness	Hardness	Taste	Colour	Overall acceptability
T_1	6.45	6.90	6.65	5.70	6.45
T_2	6.85	7.15	6.65	6.65	6.85
T_3	7.50	7.70	7.35	7.25	7.55
T_4	7.85	7.90	7.60	7.80	7.85
T_5	7.35	7.85	7.55	7.60	7.55
T_6	5.00	4.50	4.80	4.60	4.60



Radar chart for sensory evaluation

The chewiness of the extruded products ranged from 5 to 7.85. The maximum chewiness was observed for the combination of T_4 i.e.,70% pearl millet and 30% chick pea, while the lowest bulk density was found for the combination T_6 i.e., 50% pearl millet and 50% chick pea. Panelists assess the texture of the samples by considering factors like resistance to bite, toughness, and effort required for chewing.

The hardness of the extruded products ranged from 4.50 to 7.90. The maximum hardness was observed for the combination of T_4 i.e.,70% pearl millet and 30% chick pea, while the lowest bulk density was found for the combination T_6 i.e., 50% pearl millet and 50% chick pea. Panelists evaluate the samples on a 9-point scale, typically ranging from extremely soft/low hardness to extremely hard/high hardness.

The taste of the extruded products ranged from 4.80 to 7.60. The maximum taste was observed for the combination of T_4 i.e., 70% pearl millet and 30% chick pea, while the lowest bulk density was found for the combination T_6 i.e., 50% pearl millet and 50% chick pea. The taste attributes can be evaluated individually or as an overall taste impression. The specific taste attributes evaluated can vary based on the product, but commonly assessed attributes include sweetness, sourness, saltiness, bitterness, and umami.

The colour of the extruded products ranged from 4.60 to 7.80. The maximum colour was observed for the combination of T_4 i.e.,70% pearl millet and 30% chick pea, while the lowest bulk density was found for the combination T_6 i.e., 50% pearl millet and 50% chick pea. Panelists evaluate the colour based on its visual appeal, brightness, hue, and overall visual impression.

The overall acceptability of the extruded products ranged from 4.60 to 7.85. The maximum overall acceptability was observed for the combination of T_4 i.e.,70% pearl millet and 30% chick pea, while the lowest bulk density was found for the combination T_6 i.e., 50% pearl millet and 50% chick pea. The overall acceptability score provides an overall measure of preference and consumer liking for the product.

The results of this study can be valuable for food processors and manufacturers in standardizing the flour proportion for pearl millet and chickpea based extruded products. By considering the sensory attributes and consumer preferences, the optimal composition can be determined to produce extruded products with desirable sensory characteristics and high consumer acceptability. So, from the above results and discussion we can say that the treatment number T_4 i.e., 70% peal millet and 30% chick pea got highest sensory score from the panelists and it is suitable for the product preparation.

Plate 1: Extruded product prepared from (Pearl millet: Chick pea) flour proportion

4. Conclusion

The sensory evaluation of extruded products made from composite flours of pearl millet and chickpea using a twin-screw extruder was successfully conducted. The study investigated six different flour compositions, ranging from 100% pearl millet flour to 50% flour proportion. The sensory attributes evaluated included chewiness, hardness, taste, colour, and overall acceptability. In conclusion, based on the sensory evaluation, the treatment T_4 (70% pearl millet flour and 30% chickpea flour) yielded the highest sensory scores and can be considered suitable for the production of extruded products. Conversely, treatment T_6 (50% pearl millet flour and 50% chickpea flour) received the lowest sensory score and may not be the ideal composition for producing extruded products with desirable sensory attributes. These findings provide valuable insights for further product development and optimization using composite flours of pearl millet and chickpea.

5. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

6. References

1. Anonymous. Directorate of Economics and Statistics Govt. of India; c2020. Available at http://www.agricoop.nic.in, Accessed on 27th June, 2023.
2. AOAC. AOAC Official Method 942.05, Ash of Animal Feed, in Official Methods of Analysis of AOAC International, 18th edition AOAC International, Gaithersburg, MD, United States. 2005a;4(1):8.
3. AOAC. AOAC Official Method 978.10, Fiber (Crude) in Animal Feed and Pet Food, Official Methods of Analysis of AOAC International, 18th edition, AOAC International, Gaithersburg, MD, United States. 2005b;4(1):46-47.
4. AOAC. AOAC Official Method 930.15, Moisture content in Feeds, in Official methods of Association of Official Analytical Chemists (AOAC) International, 19th Edition. VA, United States; c2012a.
5. AOAC. AOAC Official Method 999.11, Determination of Lead, Cadmium, Copper, Iron and Zinc in Foods Atomic Absorption Spectrophotometry after dry ashing.

Manual for analysis of metals; c2012b. p. 1-15.
6. Deepak S, Sathyanarayana NR, Nagaraju SL, Axel M, Shekar HS. Nutritional biofortification in pearl millet. The European Journal of Plant Science and Biotechnology. 2012;6(2):87-92.
7. Dubois M, Gilles K, Hamilton J, Rebers P, Smith F. Colorimetric method for determination of sugars and related substances. Analytical Chemistry. 1956;28(3):350-356.
8. Gojiya D, Davara P, Gohil V, Dabhi M. Process standardization for formulating protein-augmented corn-based extrudates using defatted sesame flour (DSF): Sesame oil industry waste valorization. Journal of Food Processing and Preservation. 2022;e17203:1-13.
9. Hodge JE, Hofreiter BT. Determination of reducing sugars and carbohydrates. In: Whistler, R.L. and Wolfrom, M.L., Eds., Methods in Carbohydrate Chemistry, Academic Press, New York; c1962. p. 380-394.
10. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the folin phenol reagent. Journal of Biochemistry. 1951;193(1):265-275.
11. Nikmaram N, Garavand F, Elhamirad A, Beiraghi-Toosi S, Goli Movahhed G. Production of high-quality expanded corn extrudates containing sesame seed using response surface methodology. Quality Assurance and Safety of Crops and Foods. 2015;7(5):713-720. https://doi.org/10.3920/QAS2014.0507
12. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill Publishing Company; c1986. https://books.google.com/books/about/Handbook_of_Analysis_and_Quality_Control.html?id=jQN8Kpj0UOMC
13. Reddy AA, Raju SS, Suresh A, Kumar P. Analysis of pearl millet market structure and value chain in India. Journal of Agribusiness in Developing and Emerging Economies. 2018;8(2):406-424.
14. Stone H, Bleibaum R, Thomas HA. Sensory evaluation practices. Academic press; c2020.
15. Thilagavathi T, Kanchana S, Banumathi P, Ilamaran M. Standardization of extruded products using modified millet flour and pulse flour. International Journal of Food and Nutritional Sciences. 2015;4(4):73-79.
16. Ushakumari SR, Latha S, Malleshi NG. The functional properties of popped, flaked, extruded and roller-dried foxtail millet. International Journal of Food Science and Technology. 2004;39(9):907-915.