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Evaluating the nutritional and sensory characteristics of value-added bajra and kodo millet pua

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Abstract

Bajra (pearl millet) and Kodo millet are esteemed for their nutritional richness and cultural significance. Incorporating additional ingredients through value addition, such as pumpkin seeds, jaggery, dates, and amla powder, affects the overall nutritional profile and sensory attributes of pua. Five treatments of bajra and kodo millet pua were formulated and coded as T_0, T_1, T_2, T_3 and T_4. Treatment T_0 was considered a control treatment (no value addition). Value-added pua and control pua were analysed for their sensory characteristics. This study revealed that all value-added treatments of pua had better quality in terms of taste, texture, flavor, colour, and overall acceptability, scoring 8.4, 8, 8.1, 7.7, and 8.2, respectively, as compared to control products. Results indicated that the addition of jaggery, pumpkin seed, dates, and amla powder significantly enhanced the nutritional value of Bajra and Kodo Millet Pua, particularly in terms of crude protein (5.671 g), crude fiber (1.66 g), crude fat (30.01 g), vitamin C (17.99 mg), B-carotene (5.869ug), and total antioxidants (181.61 ug). Furthermore, sensory evaluation revealed positive perceptions regarding taste, aroma, texture, and overall acceptability of the value-added pua variants as compared to the control sample.

Keywords: Value addition, jaggery, kodo millet, pearl millet, total antioxidants

Introduction

In recent years, there has been a resurgence of interest in traditional and indigenous food systems, driven by a growing awareness of their nutritional value and potential health benefits (Smith *et al*., 2019). [1]. Millets, a group of small-seeded grains, have been cultivated for thousands of years and have played a crucial role in human nutrition and agriculture. Millets are highly resilient crops, well-suited to diverse climates and soil conditions, making them an essential component of food security, particularly in regions prone to drought and poor soil fertility (Kumar *et al*., 2018). [2]. Pearl millet (Pennisetum glaucum) and kodo millet (Paspalum scrobiculatum) are among the most commonly cultivated millet varieties, cherished for their nutritional density and versatility in culinary applications.

Among these, pearl millet (bajra) and kodo millet stand out as significant staples in many regions, particularly in South Asia and parts of Africa. Pearl millet is renowned for its high nutritional content, containing essential nutrients such as protein, fiber, iron, magnesium, and phosphorus (Nambiar *et al*., 2016) [3]. Similarly, kodo millet is rich in protein, dietary fiber, vitamins, and minerals, making it a valuable addition to the diet (Chandrasekara *et al*., 2011). [4]. traditionally, pua is prepared by blending millet flour with water to form a batter, which is then deep-fried or shallow-fried to create a crispy, golden-brown snack or dessert (Singh *et al*., 2020). [5]. However, with evolving dietary preferences and increasing emphasis on health-conscious consumption, there is an opportunity to enhance the nutritional profile of pua through value addition.

Pumpkin seeds, rich in protein, healthy fats, and micronutrients such as magnesium and zinc, offer a wholesome addition to the pua mixture. Jaggery, a traditional sweetener derived from sugarcane or palm sap, not only provides sweetness but also brings along a range of minerals such as iron and calcium. Dates, known for their natural sweetness and high fiber content, contribute to the nutritional density of the pua while imparting a subtle caramel flavor (Al-Farsi *et al*., 2008). [6]. Amla powder, derived from Indian gooseberries, is prized for its exceptionally high vitamin C content and potent antioxidant properties, further enriching the pua with health-promoting compounds (Sharma & Gupta, 2020) [7].

Materials and Methods

Procurement of raw material

All the raw materials were purchased from the locale market of Kanpur city.

Nutritional analysis

Proximate constituent's *viz*., moisture by oven dry method, ash contents in the sample were determined by standard

method of AOAC (2010) [14], fat content estimation by extraction method using diethyl ether [8]. Acid-Alkali digestion method" for determining crude fiber content. The protein content of samples was estimated by the Kjeldahl method.

Determination of carbohydrate

Carbohydrate was calculated by difference method by subtracting the sum of the percentages of moisture, crude protein, crude fat, crude fiber and total ash from 100.

The total CHO (%) =100- (Moisture+ Crude Protein+ Crude fat+ Crude fiber+ Total Ash)

Determination of energy kcal

The energy (kcal) was determined by summing up the value obtained by multiplying the protein and carbohydrate value with 4 and fat with 9.

Estimation of minerals

Minerals *viz*., zinc, iron magnesium calcium, phosphorus in the value added products sample were estimated in the triplicate by the method of Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is a powerful analytical technique used for the quantitative determination of trace and ultra-trace elements in samples. [9].

Estimation of vitamins

Iodometric titration method" was used for determining the concentration of ascorbic acid or Vitamin C in a sample. The method involves titrating a known volume of the sample solution with a standard iodine solution until the endpoint is reached, indicated by the formation of a dark blue-black colour due to the formation of the starch-iodine complex. By measuring the volume of iodine solution consumed at the endpoint, the amount of ascorbic acid in the sample can be calculated using the provided conversion factor.

The Spectrophotometric determination" of Beta-carotene concentration in gummy samples. Involves extracting beta-carotene from the samples using methanol, measuring the absorbance of the extracted solution at a specific wavelength (449 nm), and then comparing the absorbance values to a standard curve prepared from known concentrations of beta-carotene in methanol. [10].

Total antioxidants

DPPH assay" for determining the free radical scavenging potential of extracts. DPPH stands for 2, 2-diphenyl-1-picrylhydrazyl, a stable free radical compound. In this assay, the ability of antioxidants in the extract to neutralize the DPPH free radicals is measured spectrophotometrically.

Recipe Proportion: Bajra & Kodo millet Pua

Value added Pua in which Bajra & kodo millet, pumpkin seed, amla powder, dates and jaggery was used in the ratio of 43:43:35:5:5:4 (T_1), 35:35:40:10:10:5 (T_2), 27:27:45:15:15:6 (T_3), 19:19:50:20:20:7 (T_4). In control sample (T_0) Bajra, kodo millet, and sugar was used in the ratio of 50:50:35. Sugar is replaced by the jaggery in different proportion of value added Pua.

Table 1: Recipe Proportion: Bajra & Kodo millet Pua

Ingredients (g)	T_0 (control)	T_1	T_2	T_3	T_4
Bajra flour	50	43	35	27	19
Kodo millet flour	50	43	35	27	19
Sugar	35	-	-	-	-
Jiggery	-	35	40	45	50
Pumpkin seed	-	5	10	15	20
Dates	-	5	10	15	20
Amla powder	-	4	5	6	7
Sesame seed	5	5	5	5	5
Oil	40	40	40	40	40

Method

- Combine bajra and kodo millet flour in a bowl.
- Mix in chopped dates, crushed pumpkin seeds, and amla powder, and blend everything thoroughly.
- Heat the jaggery until it melts into a syrup consistency.
- Pour the melted jaggery syrup into the flour mixture and knead it into a dough.
- Shape the dough into small patties using your palms.
- Sprinkle sesame seeds on top of each pua for added flavour and texture.
- Heat cooking oil in a deep frying pan over medium heat.
- Once the oil is hot, carefully fry the patties until they turn golden brown and crispy on both sides.
- Remove the fried pua from the oil and drain them on paper towels to remove excess oil.

Sensory evaluation of developed product

The acceptability of value added Pua was done by the number of 30 trained, semi-trained panel members, i.e., faculty members, Ph.D. scholars, and elderly from the Department of Food Science and Nutrition College of Community Science, CSAUAT Kanpur, using a score card. Statistical analysis: the experiment was carried out in triplicate, and the data so obtained were subjected to analysis of the mean ± SD. The obtained data were interpreted at a 5% level of significance.

Results and Discussion

The results obtained from the present investigation as well as the relevant discussion have been summarized under the following headings: The mean score data were tabulated and analysed statistically; the results are presented in the table.

Table 2: Sensory evaluation of control and value added Pua

Parameters	T_0	T_1	T_2	T_3	T_4	CD (0.5%)	S.Em	F value
Taste	5.8±0.91	6.8±1.13	8.4±0.69	6.7±1.05	5.8±0.91	0.86	0.30	S
Texture	5.8±1.03	7.1±0.99	8±0.81	6.8±0.78	6.1±1.28	0.90	0.32	S
Appearance	6.9±1.19	7.1±0.99	8±0.81	6.3±1.41	6.2±0.63	0.94	0.33	S
Flavour	6.3±1.05	6.5±1.08	8.1±0.73	6.5±1.26	6.6±0.84	0.91	0.32	S
Colour	5.9±0.96	6.9±0.99	7.7±0.94	6.6±0.69	6.6±0.69	0.79	0.28	S
Overall acceptability	5.9±0.76	6.8±0.78	8.2±0.78	6.9±0.87	6.6±0.69	0.71	0.26	S

Table 2 shows that the mean sensory acceptably of value added Pua revealed that sample T_2 was score the higher values, 8.4, 8, 8, 8.1, 7.7, 8.2 in terms of test, texture, appearance, flavour, colour and overall acceptability, respectively. The sample T_0 (control) score the lowest values as compare to sample T_1, T_2, T_3, and T_4.

Table 3: Proximate composition of control and value added Pua

Nutrients	T_0	T_1	T_2	T_3	T_4	CD (0.5%)	S.Em	F value
Moisture (% mass)	5.79±0.03	5.61±0.01	5.39±0.01	5.16±0.01	4.95±0.01	0.04	0.01	S
Ash	5.599±0.01	5.318±0.02	5.019±0.01	4.781±0.01	4.445±0.01	0.01	0.1	S
Crude Protein	4.907±0.07	5.212±0.02	5.671±0.02	5.908±0.03	6.281±0.01	0.1	0.01	S
Crude Fat	25.971±0.51	27.984±0.34	30.011±0.01	32.567±0.04	34.891±0.23	0.54	0.17	S
Crude Fiber	1.1±0.01	1.39±0.01	1.66±0.01	1.89±0.01	2.13±0.01	0.02	0.01	S
Carbohydrate	55.615±0.50	53.804±0.36	52.183±0.02	49.538±0.07	46.807±0.24	0.55	0.17	S
Energy kcal (100 g)	479.61±2.58	490.63±1.63	501.69±0.08	515.47±0.47	528.311±1.11	2.65	0.84	S

Table 3 shows that the moisture content of value-added pua treatments (T_1, T_2, T_3, T_4) ranged from 5.61 to 4.95%. And 5.79% in the control sample (T_0). There was a slight decrease in moisture content in the treatment sample. The ash content in pua ranged from 5.318 to 4.445% in the treatment sample and 5.599% in the control sample. The crude protein content ranged from 5.212 to 6.281 g in the treatment sample and 4.907 g in the control sample. It had a higher protein content of all treatments (T_1, T_2, T_3, and T_4) as compared to the control (T_0) sample. The crude fat content of the value-added pua ranged from 27.984 to 34.891 g in the treatment sample and 25.971 g in the control. The crude fiber content in pua ranged from 1.39 to 2.13 g in the treatment sample and 1.1 g in the control sample. The carbohydrate content ranged from 53.804 to 46.807 g in the treatment sample and 55.615 g in the control sample. The energy content ranged from 490.63 to 528.311 kcal in the treatment sample and 479.61 kcal in the control sample.

Gupta S *et al.*, (2012) [11] reported that value-added peal millet pua had 18.46% moisture content, 22.3 g of fat, 6.43 g of protein, 0.68 g of dietary fiber, 51.13 g of carbohydrate, and 431 kcal of energy.

Kumari (2018) [12] observed that pearl millet incorporating mathri had protein, fat carbohydrate, and total ash that ranged from 10.44 to 11.65%, 17.55 to 19.44%, 59.44 to 56.54%, and 0.75 to 1.35%, respectively.

Table 4: Minerals composition of control and value added Pua

Nutrients	T_0	T_1	T_2	T_3	T_4	CD (0.5%)	S.Em	F value
Zinc (mg/100 g)	1.01±0.05	1.62±0.01	1.76±0.01	1.91±0.01	2.06±0.01	0.02	0.01	S
Iron (mg/100 g)	3.5±0.01	4.56±0.01	4.87±0.01	5.19±0.01	5.5±0.01	0.02	0.01	S
Magnesium (mg/100 g)	20.99±0.42	22.18±0.01	23.84±0.01	24.39±0.05	25.21±0.01	0.34	0.11	S
Calcium (mg/100 g)	53.18±0.1	58.17±0.01	62.99±0.30	68.28±0.01	73.24±0.01	0.25	0.08	S
Phosphorus (mg/100 g)	208.9±0.20	220.01±0.59	228.99±0.56	237.98±0.21	255.98±0.07	0.71	0.23	S

Table 4 shows that the zinc content of value-added pua treatments (T_1, T_2, T_3,T_4) ranged from 1.62 to 2.06 mg and 1.01mg in the control sample (T_0).There was a slight increase in zinc content in the treatment sample. The iron content of pua ranged from 4.56 to 5.5 mg in the treatment sample and 3.5 mg in the control sample. The magnesium content of pua ranged from 22.18 to 25.21 mg in the treatment sample and 20.99 mg in the control sample. The calcium content of pua ranged from 58.17 to 73.24 mg in the treatment sample and 53.18 mg in the control sample. The phosphorus content of pua ranged from 220.01 to 255.98 mg in the treatment sample and 208.9 mg in the control sample.

Poonam *et al.*, (2023) [13] reported that Pearl Millet Mathri had 892 kcal of energy, 16 g protein, 240 g carbohydrate, 42 g fat, 121 mg of calcium, and 7 mg of iron.

Gupta S *et al.*, (2012) [12] reported that the value-added peal millet pua had 2.199 mg of iron and 35.52 mg of calcium.

Table 5: Vitamin composition of control and value added Pua

Parameters	T_0	T_1	T_2	T_3	T_4	CD (0.5%)	S.Em	F value
Vitamin C (mg/ml)	0.01±0.05	17±0.1	17.99±0.01	18.99±0.02	19.99±0.01	0.09	0.03	s
B-carotene (µg/gm.)	0.733±0.01	5.488±0.08	5.869±0.02	6.245±0.01	6.655±0.01	0.07	0.02	s

Table 5 shows that the vitamin C content of value-added pua treatments (T_1, T_2, T_3, T_4) ranged from 17 to 19.99 mg and 0.01mg in the control sample (T_0). The B-carotene content of pua ranged from 5.488 to 6.655 µg in the treatment sample and 0.733 µg in the control sample.

Table 6: Total Antioxidant content of value added Pua

Parameters	T_0	T_1	T_2	T_3	T_4	CD (0.5%)	S.Em	F Value
Antioxidant activity IC_{50} (ug/ml)	168.254±0.02	178.339±0.02	181.61±0.1	193.698±0.05	211.338±0.02	0.28	0.09	S

Table 6 shows that the total antioxidant content of value-added pua treatments (T_1, T_2, T_3, T_4) ranged from 178.339 to 211.338 ug and 0.01 ug in the control sample (T_0).

Conclusion

The potential of utilizing indigenous grains like bajra and kodo millet, along with locally available nutritious ingredients, to develop novel and healthier food products. Bajra and Kodo millet Pua with the value addition of pumpkin seed, amla powder, jaggery, and dates provided valuable insights into the nutritional and sensory attributes. It was observed that the incorporation of these value-added ingredients not only enhanced the nutritional profile of the traditional pua but also contributed positively to its sensory characteristics, such as taste, aroma, texture, and overall acceptability. The various tests, such as proximate, vitamins, mineral estimation, and total antioxidant estimation, were analysed. The sensory acceptability of pua prepared from bajra and kodo millet flour with the addition of pumpkin seed, date, jaggery, and amla powder was analysed by panel members. T_2 (35:35:40:10:10:5) value-added sample had better sensory characteristics as compared to control (T_0) and other treatments (T, T_2, T_3, T_4). All the value-added Pua had better quality than the control value-added Pua. T_4 had the highest nutrient value as compared to other treatments (T_1, T_2 and T_3) and control (T_0), but the sensory acceptability of T_4 is lower than that of T_2.B-carotene and vitamin C content in value-added pua increased with an increase in pumpkin seed and amla powder content in the product. The overall nutritional composition of the pua has been significantly improved, offering a healthier alternative to traditional recipes. Additionally, sensory evaluation results have shown that the enriched pua maintains desirable sensory attributes, such as a pleasing taste, aroma, texture, and appearance. Moreover, the sensory acceptance of these value-added Pua's suggests their potential as a palatable and nutritious snack or meal option, particularly for individuals seeking alternative sources of nutrients or those with specific dietary requirements.

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