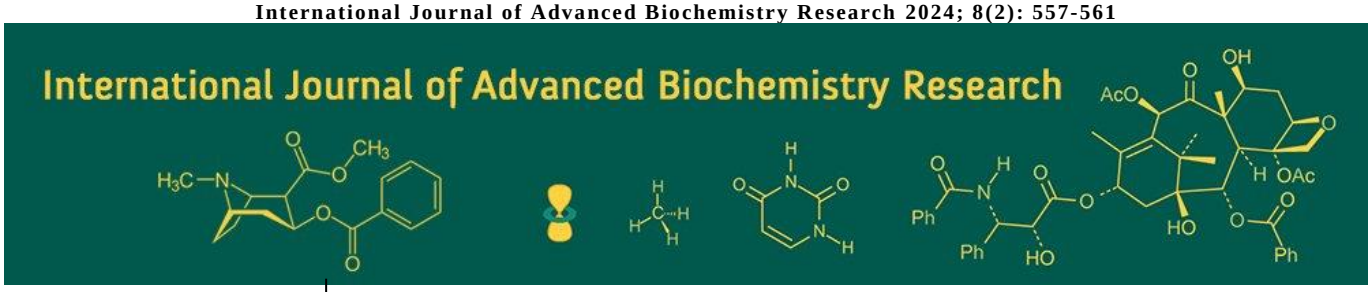

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Nutritional and organoleptic evaluation of Bajra and Kodo millet halwa with value addition of jaggery, pumpkin seed, dates and amla powder

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Abstract
Millets are gaining popularity due to their nutritional richness and making them suitable for diverse dietary preferences. Value addition in food products refers to the process of enhancing the quality, nutritional content, sensory attributes, and overall appeal of food items through the incorporation of additional ingredients. Five treatments of bajra and kodo millet halwa were formulated coded as T_0, T_1, T_2, T_3, & T_4. Treatment T_0 was considered as control treatment (no value addition). Value added halwa and control halwa were analysed for its organoleptic characteristics. This study revealed that all value added treatments of halwa had better quality in terms of colour, taste, texture, flavour and overall acceptability scored 8.4, 8.5, 8.6, 8.6, and 8.6, respectively as compared to control products. Results indicated that the value addition of jaggery, pumpkin seed, dates and amla powder significantly enhanced the nutritional value of Bajra and Kodo Millet Halwa, particularly in terms of crude protein 6.92 g, crude fiber 1.86, crude fat 31.12, vitamin-c 23.02, B-carotene 6.875 and total antioxidants 186.826. Furthermore, organoleptic evaluation revealed positive perceptions regarding taste, aroma, texture, and overall acceptability of the enriched halwa variants as compared to the control sample.

Keywords: Value addition, kodo millet, bajra, pumpkin seeds, amla powder, dates

Introduction
Millets are the oldest foods known to human beings. They are highly nutritious and easily digestible grains available in the world. They have been in food use since time immemorial and an array of traditional healthy foods are prepared across rural India. However, food use of millets is fast decreasing due to several reasons. Apart from health benefits, millets are also good source of energy, protein, vitamins and minerals. (Ravindran, 1991) [1].

The growing interest in diverse and nutritionally rich food options has led peoples to explore alternative grains and ingredients for traditional recipes. One such exploration involves the incorporation of Bajra (Pearl Millet) and Kodo Millets into a popular dessert, halwa.

Pearl millet contains approximately 67-75% carbohydrates, fat content ranging from 3 to 6%, it serves as a rich source of dietary fiber, providing approximately 1.2-12% fiber content pearl millet is a significant source of micronutrients such as iron, zinc, magnesium, and phosphorus (Gupta *et al*., 2017) [2]. Kodo millet (Paspalum scrobiculatum) is a nutritious grain cultivated in parts of Asia and Africa. It is gaining popularity due to its impressive nutritional profile. Bajra and Kodo Millets are rich sources of essential nutrients, such as dietary fiber, vitamins, and minerals, making them valuable additions to the diet (Kumar. 2020) [3]. Furthermore, the incorporation of pumpkin seed, amla powder, dates, and jaggery is intended to enhance the halwa's nutritional profile and introduce unique flavours and textures. Pumpkin seeds are recognized for their high content of essential fatty acids, antioxidants, and minerals (Babatunde & Abodunde, 2018) [4]. Amla (Indian Gooseberry) powder contributes to the halwa's vitamin C content and provides additional health benefits (Bhowmik, 2019) [5]. Dates and jaggery, natural sweeteners, not only enhance the halwa's sweetness but also provide minerals and other bioactive compounds (Mohanlal, 2018) [6]. The organoleptic evaluation will be conducted to assess the sensory attributes such as taste, aroma, texture, and overall acceptability of the enriched Bajra and Kodo Millets Halwa. Understanding both the nutritional and sensory aspects is crucial for the successful development of health-promoting and palatable food Babatunde, & Abodunde. 2018) [4].

Methods and Materials

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), fat content estimation by extraction method using diethyl ether [7]. 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 [8].

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 (449nm), and then comparing the absorbance values to a standard curve prepared from known concentrations of beta-carotene in methanol [9].

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 Halwa

Value added halwa 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 ration of 45:45:35.Sugar is replaced by the jaggery in different proportion of value added halwa.

Table 1: Recipe proportion of value added halwa

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	-	-	-	-
Jaggery	-	35	40	45	50
Pumpkin seed	-	5	10	15	20
dates	-	5	10	15	20
Amla powder	-	4	5	6	7
Fat	40	40	40	40	40

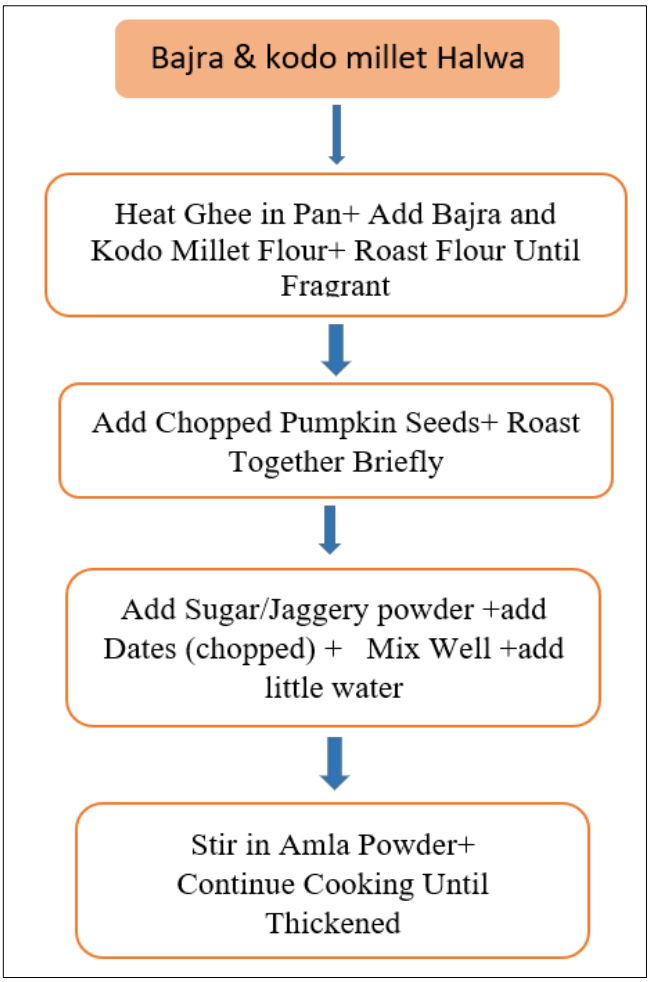

Fig 1: Preparation of Bajra & kodo millet value added halwa

Method

Ghee was heated in a pan until melted. Once the ghee is heated, add the bajra and kodo millet flour and roast them together. Add the chopped pumpkin seeds to the skillet and briefly toast them with the flour to improve their flavour. Then, add sugar or jaggery powder to the mixture, along with the chopped dates. Stir thoroughly to ensure that the ingredients are uniformly distributed. Add a tiny quantity of water to the mixture to help it bind together. Add the amla powder and continue heating until the mixture thickens to the desired consistency.

Sensory evaluation of developed product

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

Results and Discussion

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

Table 2: Mean Sensory Score of bajra & kodo millet Halwa on Nine Point Hedonic Rating Scale

Parameter	T_0 (50:50:35:40)	T_1 (43:43:35:5:5:4)	T_2 (35:35:40:10:10:5)	T_3 (27:27:45:15:15:6)	T_4 (19:19:50:20:20:7)	CD (0.5%)	S.Em	F Value
Taste	5.2±1.13	6.6±0.69	7.7±0.67	8.5±0.52	6.2±1.03	0.76	0.27	S
Texture	5.5±0.70	6.9±0.87	7.2±0.42	8.6±0.69	6.1±0.99	0.69	0.24	S
Appearance	6±0.81	6.8±0.91	7.2±0.78	8.6±0.69	6±0.94	0.75	0.26	S
Flavour	5.9±0.73	6.6±0.69	7.2±1.03	8.4±0.69	6.2±1.03	0.77	0.27	S
Colour	5.8±0.78	6.8±0.63	6.8±0.78	8.4±0.69	6.2±0.91	0.70	0.24	S
Overall acceptability	5.9±0.73	6.8±0.42	7.4±0.51	8.6±0.51	6.4±1.07	0.63	0.22	S

The mean sensory acceptability of value-added halwa revealed that sample T_3 (27:27:45:15:15:6) was liked very much, while T_1 (43:43:35:5:5:4) was liked slightly, while T_2 (35:35:40:10:10:) was liked moderately and T_4 (19:19:50:20:20:7) was liked slightly, while the control product T_0 was neither like nor dislike.

Table 3: Proximate composition of control and value added Halwa

Parameters	T_0(50:50:35:40)	T_1(43:43:35:5:5:4)	T_2(35:35:40:10:10:5)	T_3(27:27:45:15:15:6)	T_4(19:19:50:20:20:7)	CD (0.5%)	S.Em	F value
Moisture (%mass)	6.18±0.02	4.99±0.01	4.84±0.2	4.65±0.1	4.47±0.1	0.03	0.01	S
Ash (% mass)	5.009±0.01	4.772±0.057	4.502±0.07	4.296±0.02	4.163±0.04	0.08	0.03	S
Crude Protein(g/100)	5.12±0.02	5.61±0.2	6.23±0.09	6.92±0.05	7.33±0.07	0.01	0.01	S
Crude Fat (%/)	24.99±0.12	26.97±0.19	28.88±0.11	31.12±0.14	33.08±0.02	0.24	0.08	S
Crude Fiber (%/)	1.22±0.1	1.46±0.01	1.61±0.1	1.86±0.1	1.99±0.05	0.05	0.02	S
Carbohydrate (g)	57.20±0.14	55.66±0.23	53.46±0.23	50.6±0.27	48.81±0.06	0.37	0.12	S
Energy kcal(100g)	475.28±0.51	489.74±0.90	500.58±0.15	511.39±0.75	522.59±0.17	1.06	0.34	S

Table 3 shows that the moisture content of value-added halwa was 6.18% in T_0, 4.99 in T_1, 4.84 in T_2, 4.65 in T_3, and 4.47% in T_4. The ash content in halwa was 5.009% in T_0, 4.772% in T_1, 4.502% in T_2, 4.296% in T_3, and 4.163% in T_4. The crude protein content of value added halwa was 5.12 g/100 in T_0, and it increased to 5.61 g in T_1, 6.23 g in T_2, 6.92 g in T_3, and 7.33 g in T_4. The crude fat content in value added halwa was 24.99% in T_0, 26.97% in T_1, 28.88% in T_2, 31.12% in T_3, and 33.08% in T_4. The crude fiber content in value added halwa was 1.22% in T_0 and it was increased to 1.46% in T_1, 1.61% in T_2, 1.86% in T_3, and 1.99% in T_4. The carbohydrate value calculated in value added halwa was 57.20 g in T0, 55.66% in T_1, 53.46% in T_2, 50.6% in T_3, and 48.81% in T_4. The energy kcal/100g in value added halwa is 474.28 in T_0, 489.74 in T_1, 500.58% in T_2, 511.39 in T_3, and 522.59 in T_4. The statistical analysis of the data showed a significant difference among all treatments with respect to moisture, ash, crude protein, fat, fiber, carbohydrate, and energy content. Verma *et al*. (2014) prepared a foxtail millet halwa which had a nutrient composition of 1.89% protein, 9.60% fat, 0.78% fiber, 30.70% total carbohydrates, and energy value of 216 kcal/100g of halwa [10].

Table 4: Minerals composition of control and value added Halwa

Nutrients	T_0 (50:50:35:40)	T_1 (43:43:35:5:5:4)	T_2 (35:35:40:10:10:5)	T_3 (27:27:45:15:15:6)	T_4 (19:19:50:20:20:7)	CD (.05%)	S.Em	F value
Zinc (mg/100g)	1.2±0.1	1.77±0.1	1.91±0.1	2.08±0.1	2.32±0.1	0.02	0.01	S
Iron (mg/100g)	3.59±0.02	4.85±0.02	5.6±0.1	6.39±0.02	6.94±0.02	0.04	0.01	S
Magnesium(mg/100g)	21.62±0.26	22.89±0.37	23.78±0.17	24.88±0.22	25.97±0.12	0.45	0.14	S
Calcium (mg/100g)	67.89±0.02	68.11±0.05	71.09±0.02	72.31±0.36	77.66±0.35	0.42	0.31	S
Phosphorus(mg/100g)	229.1±0.35	238.15±0.02	247.41±0.02	256.24±0.01	273.14±0.02	0.28	0.09	S

Table 4 shows that the mineral content in developed value-added halwa. The zinc content in value-added halwa was 1.2 mg/100 in T_0 and increased to 1.77 in T_1, 1.91 in T_2, 1.91 in T_3, and 2.08 in T_4. The iron content of value-added halwa

was 3.59 mg/100 g in T_0 and increased to 4.85mg in T_1, 5.6 mg in T_2, 6.39 mg in T_3, and 6.94 mg in T_4. The magnesium content of halwa was 21.62 mg/100 g in T_0, and it increased to 22.89 mg in T_1, 23.78 mg in T_2, 24.88 mg in T_3, and 25.97 mg in T_4. The calcium content of halwa was 67.89 mg/100 in T_0, and it increased to 68.11 mg in T_1, 71.09 mg in T_2, 72.31 mg in T_3, and 77.66 mg in T_4. The phosphorus content of value-added halwa was 229.1 mg/100 g in T_0 and increased to 238.15 mg in T_1, 247.41 mg in T_2, 256.24 mg in T_3, and 273.14 mg in T_4. The statistical analysis of the data showed a significant difference among all treatments with respect to zinc, iron, magnesium, calcium, and phosphorus. Ojo *et al*. 2023 [11] prepared pearl millet and pumpkin leaf flour and estimated that the mean values of calcium ranged from 49.49 to 206.39 mg/100 g and from 51.86 to 202.90 mg/100 g for 24 hours and 48 hours of fermentation, respectively. Potassium content for the fermented millet and pumpkin leaf flour at 24 hrs. and 48 hrs. ranged from 145.15 to 245.02 mg/100 g and from 200.92 to 316.11 mg/100 g, respectively. The mean values of the iron content of the fermented millet grains and pumpkin leaf flour blends ranged from 76.30 to 86.19 mg/100 g and from 79.63 to 94.34 mg/100 g for 24 hrs. and 48 hrs. Of fermentation time, respectively. Iron content increased significantly (p<0.05) with an increase in pumpkin leaf flour in the flour blends.

Table 5: Vitamin composition of control and value added Halwa

Parameters	T_0(50:50:35:40)	T_1(43:43:35:5:5:4)	T_2(35:35:40:10:10:5)	T_3(27:27:45:15:15:6)	T_4(19:19:50:20:20:7)	CD (0.5%)	S.Em	F value
Vitamin C (mg/ml)	0.01±0.05	21.1±0.1	22±0.01	23.02±0.02	23.9±0.15	0.16	0.05	S
B-carotene (µg/gm.)	0.869±0.02	5.939±0.02	6.126±0.01	6.875±0.02	7.012±0.02	0.1	0.01	S

Table 5 shows that the vitamin content of the developed value-added halwa. The vitamin C content in halwa was 0.01 mg/100 in T_0, and it increased to 21.1 mg in T_1, 22 mg in T_2, 23.02 mg in T_3, and 23.9 mg in T_4. The B-carotene content of value-added halwa was 0.869 in T_0, and it increased to 5.939 in T_1, 6.126 in T_2, 6.875 in T_3, and 7.012 in T_4. The statistical analysis of the data showed a significant difference among all treatments with respect to vitamin C and β-carotene.

Table 6: Total Antioxidants content of Bajra & Kodo millet Halwa

Parameter	T_0(50:50:35:40)	T_1(43:43:35:5:5:4)	T_2(35:35:40:10:10:5)	T_3(27:27:45:15:15:6)	T_4(19:19:50:20:20:7)	CD (0.5%)	S.Em	F value
Antioxidant activity IC50 (ug/ml)	160.97±0.15	168.988±0.34	177.782±0.19	186.826±0.31	194.122±0.05	0.43	0.13	S

Table 6 shows that the total antioxidant content of value-added halwa. The total antioxidants content in value added halwa was 160.976ug/ml in T_0 and increased to 168.988ug in T_1, 177.782ug in T_2, 186.826ug in T_3, and 194.122ug in T_4. The total antioxidant content was higher in all treatment as compared to the control sample. The statistical analysis of the data showed a significant difference among all treatments with respect to total antioxidant content.

Conclusion

Bajra and Kodo Millets Halwa, with the addition of pumpkin seeds, amla powder, dates, and jaggery, provide valuable insights into the potential of these ingredients to enhance the nutritional profile and sensory attributes of traditional halwa. Through comprehensive analysis, it has been demonstrated that the incorporation of pumpkin seeds contributes essential nutrients such as protein, fiber, and healthy fats, while the addition of amla powder introduces a tangy flavour and boosts the antioxidant content of the halwa. Furthermore, the inclusion of dates and jaggery not only adds natural sweetness but also provides additional vitamins and minerals. The various tests, such as proximate, vitamins, mineral estimation, and total antioxidant estimation, were analysed. Sensory acceptability of halwa prepared from bajra and kodo millet flour with the addition of pumpkin seed, date, jaggery, and amla powder was analysed by panel members. T_3 (27:27:45:15:15:6) value-added products had better sensory characteristics as compared to control (T_0) and other treatments (T_1, T_2, T_4). All the value-added halwa had better quality than the control value-added halwa. T_4 had the highest nutrient values 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_3. B-carotene and vitamin C content in value-added halwa increased with an increase in pumpkin seed and amla powder content in the product. The overall nutritional composition of the halwa has been significantly improved, offering a healthier alternative to traditional recipes. Additionally, sensory evaluation results have shown that the enriched halwa maintains desirable sensory attributes, such as a pleasing taste, aroma, texture, and appearance. These findings underscore the potential of Bajra and Kodo Millets Halwa with value-added ingredients as a nutritious and palatable dietary option.

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