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Utilization of Bathua leaves and garden cress seeds for the development of value-added mayonnaise

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Abstract
Background: The study aimed to develop a value-added food product by incorporating Bathua leaves, Garden cress seeds, and Cinnamon herbs into Mayonnaise made from milk in ratios of T_0 (40:0:0:0), T_1 (34:6:4:0.5), T_2 (32:8:5:0.5) and T_3 (30:10:6:0.5)% and to evaluate the acceptability and chemical composition of the product.
Methods: The mayonnaise were prepared using the method with slight changes. A nine-point hedonic scale was used for sensory evaluation. Moisture, ash, protein, fat, carbohydrate, iron calcium and DPPH were analysed using AOAC a standard analytical procedures. Data were analysed using Analysis of Variance ANOVA and significant level was chosen at $p<0.05$.
Result: The results showed that T_2 had the highest score for colour, texture, taste, and overall acceptability of mayonnaise that differed significantly ($p<0.05$) with panellists preferring formulations made from powder of 8% Bathua leaves, 5% GCSs and 0.5% of cinnamon. The incorporation of prepared leaves and seed powder in the best product (T2) led to an increase in its chemical composition. The moisture content of the Mayonnaise was measured at 5.65%. The ash content was found to be 3.36g/100g. The protein content was 3.36 g/100g, while the fat content was 42.06 g/100g. The product contained 1.1g/100g of fiber and 33.73g/100g of carbohydrates. The energy content was measured at 559 kcal. In terms of micronutrients, the Mayonnaise contained 3.37 mg/100g of iron and 22mg/100g of calcium. Additionally, the DPPH radical scavenging activity was determined to be 66.5%. The cost of the Mayonnaise per 100g of dry ingredients varied across the treatments, with T0 (control) priced at Rs. 19.98, T1 at Rs. 20.47, T2 at Rs. 20.48, and T3 at Rs. 20.48. The study suggests that Bathua leaves and Garden cress seeds can be incorporated into food products to enhance their nutritional properties and sensory acceptability.

Keywords: Bathua leaves, garden cress seeds, cinnamon, mayonnaise, sensory evaluation, chemical composition

Introduction
In recent years, there has been a growing interest in functional foods that provide additional health benefits. Bathua leaves and Garden cress seeds are two plant materials known for their high nutritional value and potential health benefits. Bathua leaves, rich in vitamins A and C, iron, calcium, and other minerals, have been analyzed for their nutritional content, antioxidant properties, and antibacterial activity. (Pandey *et al*., 2016) [7] revealed that the *Chenopodium album* is known as a rich source of zinc, flavonoids, glycosides, carbohydrates, oleic and stearic. (Pandey and Gupta, 2014) [9] stated that bathua consumption can help alleviate many illnesses. Despite its decline in consumption, bathua leaves have shown potential as a functional food ingredient in dishes like raita and paratha.
Garden cress seeds, on the other hand, are highly nutritious and contain protein, fiber, vitamins, minerals, and essential fatty acids. They have been traditionally used in culinary preparations and are known for their medicinal properties in treating various ailments. (Singh and Paswan, 2017) [13] concluded that seeds of garden cress plants are good sources of amino acids, minerals, and fatty acids and can act as *in vivo* as well as *in vitro* antioxidants due to their high content of phenolic compounds. (John *et al*., 2020) [5] concluded that roasted garden cress seeds can be successfully incorporated up to 30 percent for the development of nutrient-rich cutlets without compromising the sensory acceptability.
Cinnamon, derived from the inner bark of certain tree species, is renowned for its flavor and fragrance.

It has been studied for its potential role in blood sugar control, inflammation reduction, and cognitive function enhancement. (Wickremesinghe *et al*., 2018) [16] concluded that all the cinnamon samples used for the study could enhance the glucose uptake in yeast cells suggesting that they may influence controlling blood glucose levels in humans. (Nabavi *et al*., 2015) [8] stated that the ability of cinnamon to combat bacteria is attributed to its bioactive phytochemicals, including cinnamaldehyde and eugenol. These compounds possess antimicrobial properties that can help reduce or prevent bacterial decay in various applications, such as food products and cosmetics.

Mayonnaise, a popular condiment, typically consists of oil, egg yolks, and vinegar or lemon juice. By incorporating Bathua leaves and Garden cress seeds into mayonnaise, it can be transformed into a more nutritious and functional food product. This study aims to develop value-added mayonnaise and evaluate its nutrient composition and sensory acceptability. The findings could contribute to the development of functional foods that address nutritional deficiencies associated with impaired cognitive development, weakened immune function, and increased risk of chronic diseases and infections.

Methods and Materials

The recent investigation took place in March 2023 in the Nutrition Research Laboratory located at Ethelind College of Home Science, Sam Higginbottom University of Agriculture, Technology and Sciences in Prayagraj, Uttar Pradesh. The primary objective of the study was to create value-added food products. To accomplish this, the research team obtained Bathua leaves, Garden cress seeds, Bajra, and Cinnamon from the local market in Prayagraj.

Preparation of food product

Preparation of food product Mayonnaise with the incorporation of bathua leaves powder, garden cress seeds powder, cinnamon powder, and other raw materials. For each basic recipe (control T_O) has three variations T_1 (Milk + Oil +Bathua leaves powder + Garden cress seed powder+ cinnamon powder in the ratio of 34:55.5:6:4:0.5), T_2 (Milk + Oil +Bathua leaves powder + Garden cress seed powder+ cinnamon powder in the ratio of 32:54.5:8:5:0.5), T_3, (Milk + Oil +Bathua leaves powder + Garden cress seed powder+ cinnamon powder in the ratio of 30:53.5:10:6:0.5), respectively, where the amount of one or more ingredients is varied. The ingredient used for the preparation of Mayonnaise are Chilled milk, Vinegar, Salt, Sugar and Oil.

Sensory evaluation: The acceptability of the food products will be evaluated by a panel of five judges through a sensory assessment. The judges will use a scorecard based on a 9-point Hedonic Scale to evaluate attributes such as color and appearance, body and texture, taste and flavor, as well as overall acceptability. This evaluation process is designed to assess the sensory characteristics and overall desirability of the developed food products (Srilakshmi, 2023) [15].

Chemical analysis: The proximate composition analysis, including moisture, ash, crude protein, crude fat, and crude fiber, was conducted following standard methods outlined by the AOAC (2023) [2]. The moisture content of both raw and processed leaves was determined by subjecting the samples to drying in a Hot air oven at 105 ºC. Total ash content was estimated using a muffle furnace. Protein content was calculated using Lowry's Method. Crude fat was extracted from the samples using petroleum ether through a continuous extractor known as the Soxhlet Method. For fiber analysis, an acid-alkali washing method was employed (Extraction Method). To calculate the available carbohydrates, the values of moisture, crude protein, crude fat, fiber, and ash were summed and then subtracted from 100 (Calculation Method). Gross energy was computed using the formula [Gross Energy = (Crude protein × 4) + (Crude fat × 9) + (Carbohydrate × 4)]. Calcium content was determined using the Titration Method, while iron content was measured through the colorimetric method. The antioxidant activity of the developed food products was evaluated using the DPPH (2, 2-diphenyl-1-picrylhydrazyl) Method.

Cost calculation: The cost of the prepared product was determined by considering the prevailing market prices of the individual raw ingredients used in its preparation. The cost of each ingredient was taken into account to calculate the overall cost of the food product.

Statistical analysis: The data were analysed by analysis of variance technique (ANOVA), Critical Difference, and other appropriate statistical analytical methods and interpreted the data (Gupta and Kapoor, 2018) [4].

Results and Discussion

Sensory evaluation of prepared product 'Mayonnaise'

According to the results presented in Figure 1, T_2 received the highest scores for attributes such as color and appearance. This can be attributed to the light green color, which was visually appealing. Furthermore, T_2 exhibited a smooth and uniform consistency without any lumps or separation, contributing to its favorable score for body and texture. The taste and flavor of T_2 were perceived as balanced and tangy, with a hint of saltiness, resulting in a higher score in this category. Overall, the acceptability of T_2 was found to be superior, indicating that the combination and ratio of 8% Bathua leaves powder, 5% Garden cress seed powder, and 0.5% Cinnamon powder used in T_2 were more well-liked by the panel of judges compared to the other treatments. Based on the sensory evaluation, it can be concluded that T_2 outperformed T_1 and T_3 in terms of sensory characteristics, taste, and overall acceptability. These findings suggest that T_2, with its favorable sensory properties, offers an enhanced eating experience, adding flavor, creaminess, and texture to various dishes and sandwiches.

The results are supported by the finding of Salgado *et al*., (2006) [12]. The intention was to incorporate aromatic herbs in mayonnaise with the highest sensory scores and acceptance of the product. It was observed regarding the sample's preference containing sesame and olive oil and the difference from the control test can conclude that the mayonnaise samples with sesame, coconut, and olive oils are different in the significance level of 5% with regards to soybean oil mayonnaise. In the attribute test, there was no significant difference in preference between the aromatized samples.

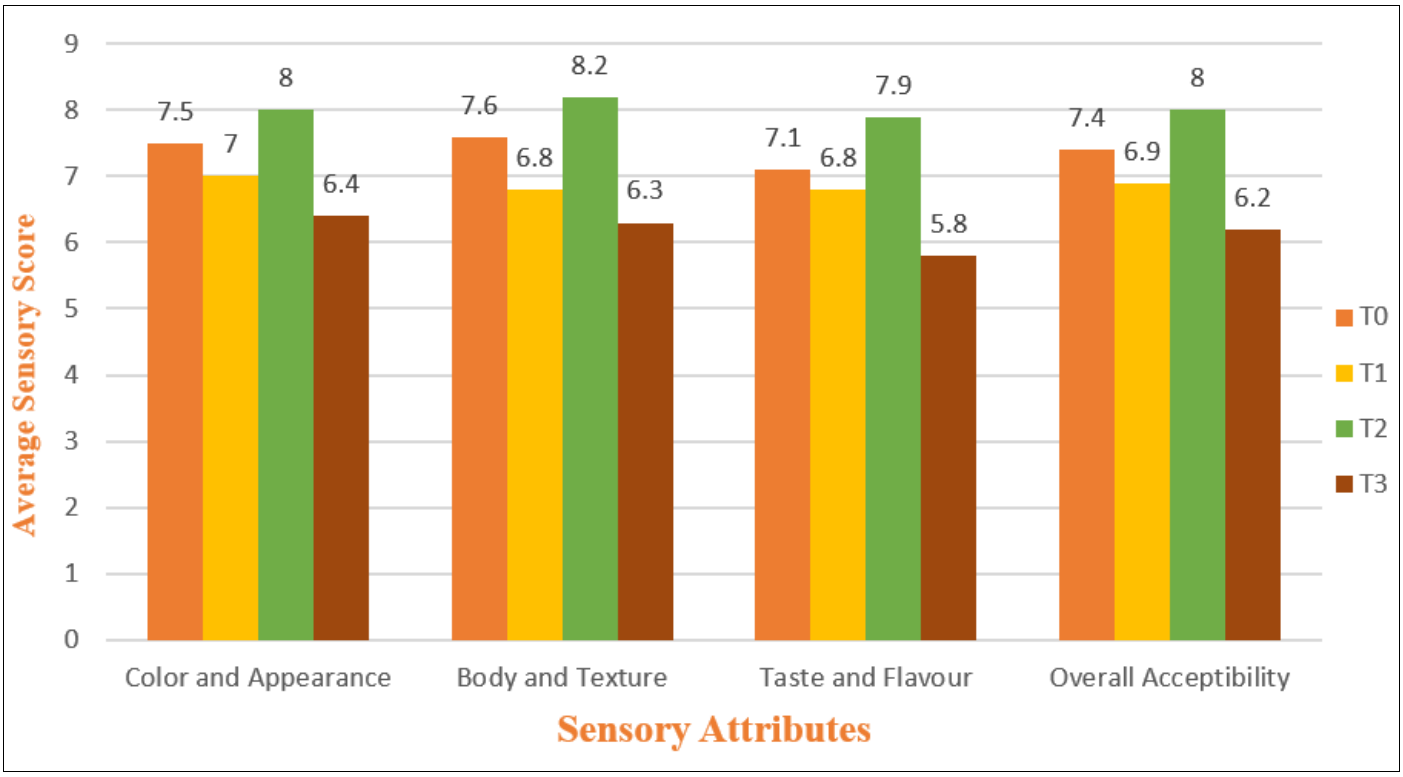

Fig 1: Average sensory scores for different attributes of 'Mayonnaise'

Plates

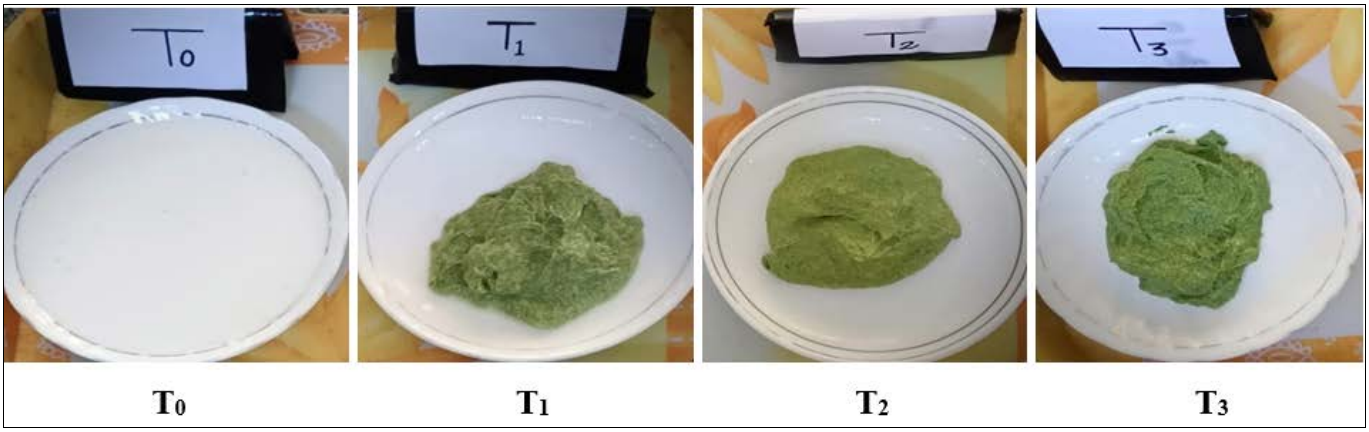

Plate 1: Developed value-added Mayonnaise

Nutritional composition of Developed product 'Mayonnaise'

Table 1 presents the differences between the control sample and the best treatment (T_2) in terms of various nutrient content in the developed product. The moisture content of the product decreases in T_2 due to the incorporation of dehydrated Bathua leaves and a reduction in the amount of milk and oil. This indicates that the product retains less moisture. In contrast, the ash, protein, and crude fiber content increase in T_2. This is attributed to the inclusion of garden cress seeds, which are known to be a good source of these nutrients. Garden cress seeds contribute to a higher concentration of ash, protein, and dietary fiber in the final product. The fat content was also increased in T_2 as a result of formulation in treatments. The carbohydrate content of T_2 decreases due to the addition of garden cress seed powder, which has a lower carbohydrate content compared to other ingredients. As a result, the carbohydrate content of T_2 is lower than that of the control sample. However, the energy, iron, calcium, and antioxidant properties increase in T_2. This is attributed to the higher incorporation levels of Bathua leaves and cinnamon powder. Bathua leaves and cinnamon are known to be rich sources of nutrients such as iron, calcium, and antioxidants. Hence, the higher inclusion of these ingredients in T_2 contributes to an increase in these nutrient levels in the final product. The tabulated value at a significance level of 5% was 4.303, indicating that the differences observed in the nutrient content between the control and T_2 were statistically significant. Moreover, all the evaluated nutrients were found to be satisfactory in terms of their content in the developed product. Overall, the incorporation of dehydrated Bathua leaves garden cress seeds, and cinnamon powder in T_2 resulted in changes in nutrient composition, including increased protein, fiber, iron, calcium, and antioxidant properties, decreased fat and carbohydrate content, and increased moisture content. These changes were statistically significant and contributed to the overall nutritional profile of the developed product.

The result is supported by the findings of Singh *et al.*, (2007) [14] prepared value-added products from dehydrated C. album leaves. They incorporated dehydrated leaves at 3–15% levels in two conventional foods namely green gram dal and paratha. Results showed that dehydrated leaves were a rich source of protein, carbohydrate and ash. Iron content of dehydrated Bathua leaves (27.48mg/100g) was 6-8 times higher than fresh leaves. Green gram dal and paratha incorporated with 7 and 5 percent dehydrated Bathua leaves were liked most. Iron content of green gram dal (8.8mg/100g) and paratha incorporated with dehydrated Bathua leaves was higher than their respective control. Therefore, it can be concluded that the incorporation of dehydrated Bathua leaves in various conventional food items can improve the nutritional quality of the products as well as add variety to the diet.

The result is supported by the findings of Poonia and Upadhayay, (2015) [10] reported that the antioxidant activity of leaves extract of C. album was 84.89 % determined by DPPH assay. C. album is a good source of functional nutrients and possesses medicinal properties. Thus, it can be concluded that it can be incorporated into different extruded food products to make them more nutritious, healthier as well as consumer-oriented. The plants also have high biological activities and hence may be of great medicinal value.

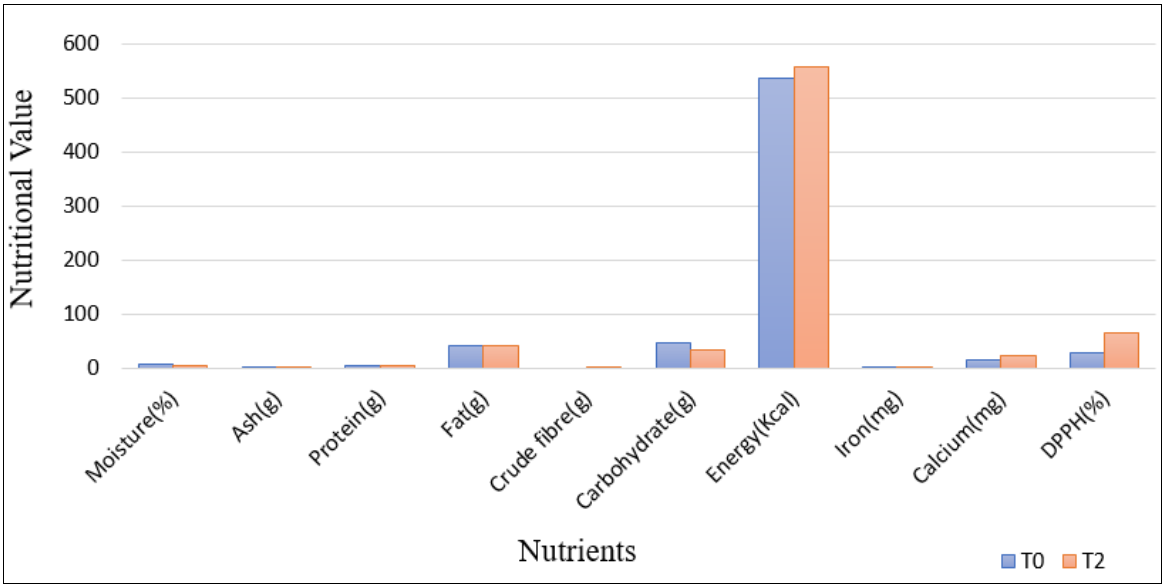

Fig 2: Nutritional composition of developed value added Mayonnaise

Table 1: The average nutritional composition of control and best treatment sample of 'Mayonnaise' per 100 g.

Nutrients	(T_0)	(T_2)	Difference (T_2-T_1=D)	t(calculated)
Moisture (%)	6.93	5.65	1.66*	26.01
Ash(g)	1.42	3.36	2.58*	25.26
Protein (g)	3.8	7.9	4.34*	39.23
Fat (g)	41.02	44.36	12.38*	7.06
Crude fibre (g)	0	1.1	0.36*	9.76
Carbohydrate(g)	46.83	33.73	11.96*	8.15
Energy (kcal)	537	559	81*	12.42
Iron (mg)	0.56	4.47	15.6*	11.95
Calcium (mg)	16.2	22	35.94*	60.11
DPPH radical scavenging activity (%)	29.7	66.5	59.85*	57.41

t(tabulated) value at 5% = 4.303, Result = Satisfactory (*).

Cost of the prepared product 'Mayonnaise'

The cost of prepared mayonnaise per 100g of dry ingredients, considering the prevailing cost of raw materials, was found to be Rs. 19.98 for the control variant (T0), Rs. 20.47 for T_1, Rs. 20.48 for T_2, and Rs. 20.48 for T_3. These different costs are a result of ingredient modifications and additions made during the production process. Each variant has its own unique combination and quantity of ingredients, which directly impacts the overall expense of producing the mayonnaise per 100g of dry ingredients. Thus, the varying costs reflect how the ingredient modifications and additions influence the total cost of producing the mayonnaise variants, considering the specific combination and quantity of ingredients used in each variant.

Conclusion

In conclusion, the study found that incorporating powder of Bathua leaves, Garden cress seeds, and cinnamon into refined milk resulted in the improved nutritional value of mayonnaise. Among the different treatments, the mayonnaise with 8% Bathua leaves powder, 5% Garden cress seed powder, and 0.5% cinnamon powder (T_2) was the most well-liked based on sensory evaluation at significant level (p<0.05). The inclusion of these ingredients led to significant increases in ash, fat, protein, fiber, energy, iron, calcium and antioxidant content in the mayonnaise. Although the cost of production increased, it remained relatively cheaper compared to the control variant. This fortified mayonnaise offers enhanced nutritional bioavailability compared to commercially available options. Hence, it can be

recommended as a valuable product for individuals with micronutrient deficiencies, including those suffering from anemia. Micronutrient deficiencies can adversely impact cognitive development, weaken immune function, and increase the risk of chronic diseases and infections.

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