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Evaluation of Physico-chemical and Organoleptic Properties of Value Added Lotus Stem Pickle

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Lotus stem or kamal kakdi, is (most of the times wrongly called as lotus root) very popular vegetable in India and several other Asian countries including China and Japan. Pickles are one of the oldest and famous and easy method to preserve store any vegetables or fruits for long time use. The current experiment was carried out to prepare the lotus stem pickle value added with carrot and green chilli using different vinegar like apple vinegar, jamun vinegar, sugarcane vinegar with the objective to assess the physico-chemical and organoleptic properties of the pickle. The experiment was conducted in Completely Randomized Design (CRD), with nine treatments and three replications. Based on the statistical analysis, it was observed that treatment T8 (Lotus stem + Green chili + Carrot + Sugarcane vinegar) was found best in terms of physico-chemical properties *viz.* pH, acidity (%), total soluble solids (^{o}Brix), vitamin C (mg/100g), total sugar (%).

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Based on the statistical analysis, it was observed that treatment T6 (Lotus stem + Green chili + Carrot + Apple vinegar) was found best in terms organoleptic properties *viz.* colour, taste, flavour, texture and overall acceptability. By promoting the production and consumption of lotus stem pickle, we contribute to minimizing agricultural losses, fostering awareness about this nutritious vegetable and enriching culinary experiences.

Keywords: Lotus stem; organoleptic properties; pickle; physico-chemical properties; vinegar.

1. INTRODUCTION

Nelumbo nucifera, commonly known as lotus or sacred lotus is an aquatic perennial plant belonging to family Nelumbonaceae [1]. Lotus stem or *kamal kakdi,* is (most of the times wrongly called as lotus root) very popular vegetable in India and several other Asian countries including China and Japan. Lotus stem is loaded with nutrients, it contains abundant amount of protein, amino acids, dietary fibre, starch and Vitamin C, Vitamin B1 and Vitamin B2 and has some tremendous health benefits. It has high iron, calcium, dietary fibre and effective constituents like starch, protein, asparagines, pyrocatechol, gallic-catechin, neochlorogenic acid, leucocyanidin, peroxides, vitamins B and C. Lotus stem has extraordinary medicinal value [2-5]. It is used for curing fever, diarrhea, hemorrhages, dysentery, high BP, excessive menstruation. Even after such good functional qualities it is found to be under consumed vegetable. Incorporation of this in traditional ingredients is best way to introduce them in daily diet of people. It is widely favored by Asian because of its hard and crispy texture and distinctive aroma and taste. It is often used to make dishes such as salads, pickled vegetables, stir-fried foods and confections. Because lotus root contains a high concentration of polyphenolic compounds, it possesses good antioxidant activity [6]. Lotus stem is beneficial in relieving constipation, promote digestive health, It has cholesterol lowering property, low glycemic index, control high blood pressure, it has antioxidant property, support nervous system, anti-viral and anti-bacterial property, promote bone health and help in weight loss [7] The rhizomes, which are 60-140 cm long and 0.5 to 2.5 cm in diameter, bear nodes, each of which produces a leaf [8]. The colour of the rhizome varies from yellowish white to yellowish brown in colour, smooth longitudinally striated with brown patches, nodes and internodes are present [9]. The lotus rhizome and its extracts have shown diuretic, psycho-pharmacological, anti-diabetic, anti-obesity, hypoglycemic, antipyretic and antioxidant activities [10].

Carrot (*Daucus carota* L.) is the most important crop of Apiaceae family. It is a root vegetable that has worldwide distribution. Carrots were first used for medical purposes and gradually used as food. A rapid rise in the popularity of orange carrots was observed with the recognition of its high provitamin A content [11]. It is one of the important root vegetables rich in bioactive compounds like carotenoids and dietary fibers with appreciable levels of several other functional components having significant health-promoting properties. In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A [12,13]. It contains many important vitamins and minerals and rich in antioxidants beta-carotene which have protective properties against certain forms of cancer and cardiovascular diseases [14].

Green chilli (*Capsicum frutescens* L.) is a good source of plant derived chemical compounds that are known to have disease preventing and health promoting properties. Fresh chillies are an excellent source of vitamin A, tocopherol and ascorbic acid as well as neutral and acidic phenolic compounds which are important antioxidants [15,16,17]. They are also good sources of provitamin A, carotenoid, viz., β-carotene, α-carotene, β-cryptoxanthin and oxygenated carotenoids or xanthophylls which can vary in composition and concentration due to differences genetics and degree of ripening [18].

Pickling is the oldest and useful method used for the preservation of food by anaerobic fermentation or immersion in the vinegar and resulting food is called pickle. The word pickle is derived from Dutch language “pekel” which mean brine. Pickle is fermented food which contains various vegetables (beans, carrot, mango, green tomatoes, pepper, cabbage etc.) and spices while additives are added for the taste improvement. Sweet, vinegar, salt and oil pickles are very common commercial manufacture varieties. Salt pickle contains fresh and pure

materials and salt; it is preserved with 12-15%. Basically, lactic acid bacteria are used for the conversion of sugar into acid [19,20].

Pickling process is used to preserve the vegetables for long time. Vinegar and vegetable oil is used as pickling medium in Asia [21]. Pickles contain phytochemicals and minerals which come from ingredients (Vegetables and spices), therefore pickles are useful against different diseases such as cancer, inflammation, brain dysfunction, atherosclerosis. The bioactive compounds are phenolic acids mostly flavonoids and tannins which scavenge the free radicals which are harmful for health and cause different diseases [22,23].

Lotus stem pickle is a delicious and healthy condiment that adds a burst of flavour to any dish. Its unique texture and taste make it a popular choice for Indian cuisine enthusiasts, while its health benefits have made it a staple in traditional medicine for centuries. Value added lotus stem pickle will develop the interest of people towards preparing of lotus stem pickle which will increased the products of lotus stem in the market. This will help to minimize the losses of lotus stem and to bring awareness about the value addition of lotus stem and also to make the off-season availability of lotus stem pickle.

2. MATERIALS AND METHODS

The experiment was conducted in the Post-harvest Technology Laboratory, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2022-2024. The experiment was laid out in Completely Randomized Design (CRD) having 09 treatments with three replications. The treatments were T_0 (Control), T_1 (Lotus stem + Apple vinegar), T_2 (Lotus stem + Jamun vinegar), T_3 (Lotus stem + Sugarcane vinegar), T_4 (Lotus stem + Vinegar + Sugar), T_5 (Lotus stem + Green Chilli + Carrot), T_6 (Lotus stem + Green Chilli + Carrot + Apple vinegar), T_7 (Lotus stem + Green Chilli + Carrot + Jamun vinegar), T_8 (Lotus stem + Green Chilli + Carrot + Sugarcane vinegar).

2.1 Preparation and Storage of Lotus Stem Pickle

The lotus stem was washed thoroughly, peeled, cut into slices and boiled until soft, then left to sun dry to remove moisture. After drying, the slices were placed into a container and oil and spices added. The mixture was stirred well with a spoon to ensure the spices were thoroughly mixed with the slices. Vinegar and sodium benzoate were then added to the mixture. The pickle was filled into sterilized plastic bottles and stored at ambient room temperature.

2.2 Evaluation of Physico-chemical Properties of Lotus Stem Pickle

The value added lotus stem pickles were evaluated for various physico-chemical properties like pH, acidity, TSS, moisture, vitamin C, total sugar. The pH content was analyzed by digital pH meter. The acidity content was analyzed by titration method. The TSS content was analyzed using a hand refractometer, while the moisture content was analyzed using the oven dry method. The vitamin C content was analyzed by 2, 6-dicholorophenol-inndophenol visual titration method. The total sugar content was analyzed by lane and eynon method. The recorded data of all samples for different parameters were tabulated and statistically analyzed to find out the most suitable treatment combination in terms of physico-chemical properties.

2.3 Evaluation of Organoleptic Properties of Lotus Stem Pickle

The value added lotus stem pickles were evaluated by a panel of five judges to determine colour, taste, flavour, texture and overall acceptability. Each sample was evaluated and given a score by the panelists on the scale of 1-9 using hedonic rating method. The mean scores of all samples of all the five members were tabulated and statistically analyzed to find out which treatment combination is most acceptable in terms of organoleptic properties.

3. RESULTS AND DISCUSSION

3.1 Physico-chemical Properties of Lotus Stem Pickle

The nutritional value of lotus stem pickle was evaluated by analyzing its physico-chemical properties like pH, acidity, TSS, moisture, vitamin C and total sugar. The data recorded on physico-chemical properties of lotus stem pickle have been presented in Table 1.

3.1.1 Effect of different treatments on ph of lotus stem pickle

Statistical analysis revealed that pH content differed significantly across all treatments. The mean values of pH content ranged from 4.30 to 5.02%. The minimum pH content 4.30 was recorded in T_8 (Lotus stem + Green chili + Carrot

+ Sugarcane vinegar), while the maximum pH content 5.02 was recorded in T_1 (Lotus stem + Apple vinegar). Similar result were reported by Mondal et al. [24] in jackfruit pickle; Pal et al. [25] in wood apple pickle; Kokani and Mohape [26] in carrot pickle; Sultana et al. [27] in carrot, green chilli and brinjal pickle.

3.1.2 Effect of different treatments on acidity of lotus stem pickle

Statistical analysis revealed that acidity content differed significantly across all treatments. The mean values of acidity content ranged from 0.78 to 1.37%. The minimum acidity content 0.78% was recorded in T_2 (Lotus stem + Jamun vinegar), while the maximum acidity content 1.37% was recorded in T_8 (Lotus stem + Green chili + Carrot + Sugarcane vinegar). Similar results were reported by Mir et al. [28] in carrot pickle; Kokani and Mohape [26] in carrot pickle; Sultana et al. (2021) in carrot, green chilli and brinjal pickle; Rymbai and Chaurasiya [29] in carrot, pea and ginger pickle.

3.1.3 Effect of different treatments on total soluble solids of lotus stem pickle

Statistical analysis revealed that TSS content differed significantly across all treatments. The mean values of TSS content ranged from 17.14 to 26.17°Brix. The minimum TSS content 17.14°Brix was recorded in T2 (Lotus stem + Jamun vinegar), while the maximum TSS content 26.17°Brix was recorded in T4 (Lotus stem + Vinegar + Sugar). Similar results were reported by Pal et al. (2018) in wood apple pickle; Verma et al. [30] in wood apple pickle.

Table 1. Effect of different treatments on Physico-chemical properties of Lotus Stem Pickle

Treatment	pH	Acidity (%)	TSS (°Brix)	Moisture (%)	Vitamin C (mg/100g)	Total Sugar (%)
T_0	4.58	1.02	18.15	45.47	9.01	5.10
T_1	5.02	0.80	17.66	45.95	9.72	5.45
T_2	4.87	0.78	17.14	46.47	10.99	5.37
T_3	4.96	0.87	18.27	46.53	10.09	5.22
T_4	4.64	0.90	26.17	46.36	11.80	7.48
T_5	4.38	1.28	19.89	47.65	12.91	6.27
T_6	4.41	1.26	20.16	48.17	14.21	6.46
T_7	4.52	1.30	20.34	48.27	13.67	6.22
T_8	4.30	1.37	21.27	49.03	14.46	6.31
F-test	S	S	S	S	S	S
SE(d)	0.045	0.044	0.171	0.281	0.445	0.206
CV	1.202	5.082	1.053	0.725	4.585	4.214
CD at 5%	0.096	0.093	0.359	0.590	0.934	0.433

Table 2. Effect of different treatments on Organoleptic properties of Lotus Stem Pickle

Treatment	Colour	Taste	Flavour	Texture	Overall acceptability
T_0	4.7	4.7	4.3	4.3	5.3
T_1	7.0	7.3	7.3	6.7	6.7
T_2	6.7	7.0	7.0	7.0	7.3
T_3	6.7	7.0	7.0	6.7	6.7
T_4	7.0	7.3	7.3	7.3	7.0
T_5	7.7	7.7	7.7	7.0	7.3
T_6	8.3	8.7	8.7	8.3	8.7
T_7	8.0	8.3	8.3	7.7	8.3
T_8	8.0	8.3	8.0	8.0	8.3
F-test	S	S	S	S	S
S.Ed	0.588	0.497	0.471	0.471	0.521
CV	10.126	8.257	7.193	8.248	8.748
CD at 5%	1.235	1.044	0.990	0.990	1.095

3.1.4 Effect of different treatments on moisture of lotus stem pickle

Statistical analysis revealed that moisture content differed significantly across all treatments. The mean values of moisture content ranged from 45.47 to 49.03%. The minimum moisture content 45.47% was recorded in T_0 (Control), while the maximum moisture content 49.03% was recorded in T_8 (Lotus stem + Green chili + Carrot + Sugarcane vinegar). Similar results were reported by Mondal et al. [24] in jackfruit pickle; Ali et al. [31] in brinjal pickle; Rymbai and Chaurasiya [29] in carrot, pea and ginger pickle; Meena et al. [32] in mango pickle.

3.1.5 Effect of different treatments on vitamin c of lotus stem pickle

Statistical analysis revealed that vitamin C content differed significantly across all treatments. The mean values of vitamin C content ranged from 9.01 to 14.46mg/100g. The minimum vitamin C content 9.01mg/100g was recorded in T_0 (Control), while the maximum vitamin C content 14.46mg/100g was recorded in T_8 (Lotus stem + Green chili + Carrot + Sugarcane vinegar). Similar results were reported by Rymbai and Chaurasiya [29] in carrot, pea and ginger pickle; Meena et al. [32] in mango pickle.

3.1.6 Effect of different treatments on total sugar of lotus stem pickle

Statistical analysis revealed that total sugar content differed significantly across all treatments. The mean values of total sugar content ranged from 5.10 to 7.48%. The minimum total sugar content 5.10% was recorded in T_0 (Control), while the maximum total sugar content 7.48% was recorded in T_4 (Lotus stem + Vinegar + Sugar). Similar results were reported by Thakur et al. [33] in mango pickle; Saroj and Singh [34] in mango pickle; Meena et al. [32] in mango pickle [35].

3.2 Organoleptic Properties of Lotus Stem Pickle

The sensory acceptability of lotus stem pickle was evaluated by analyzing its organoleptic properties like colour, taste, flavour, texture and overall acceptability. The data recorded on organoleptic properties of lotus stem pickle have been presented in Table 2.

3.2.1 Effect of different treatments on colour of lotus stem pickle

Statistical analysis revealed that organoleptic score for colour differed significantly across all treatments. The mean values of organoleptic score for colour ranged from 4.7 to 8.3. The minimum organoleptic score 4.7 for colour was recorded in T_0 (Control), while the maximum organoleptic score 8.3 for colour was recorded in T_6 (Lotus stem + Green chili + Carrot + Apple vinegar).

3.2.2 Effect of different treatments on taste of lotus stem pickle

Statistical analysis revealed that organoleptic score for taste differed significantly across all treatments. The mean values of organoleptic score for taste ranged from 4.7 to 8.7. The minimum organoleptic score 4.7 for taste was recorded in T_0 (Control), while the maximum organoleptic score 8.7 for taste was recorded in T_6 (Lotus stem + Green chili + Carrot + Apple vinegar).

3.2.3 Effect of different treatments on flavour of lotus stem pickle

Statistical analysis revealed that organoleptic score for flavour differed significantly across all treatments. The mean values of organoleptic score for flavour ranged from 4.3 to 8.7. The minimum organoleptic score 4.3 for flavour was recorded in T_0 (Control), while the maximum organoleptic score 8.7 for flavour was recorded in T_6 (Lotus stem + Green chili + Carrot + Apple vinegar).

3.2.4 Effect of different treatments on texture of lotus stem pickle

Statistical analysis revealed that organoleptic score for texture differed significantly across all treatments. The mean values of organoleptic score for texture ranged from 4.3 to 8.3. The minimum organoleptic score 4.3 for texture was recorded in T_0 (Control), while the maximum organoleptic score 8.3 for texture was recorded in T_6 (Lotus stem + Green chili + Carrot + Apple vinegar).

3.2.5 Effect of different treatments on overall acceptability of lotus stem pickle

Statistical analysis revealed that organoleptic score for overall acceptability differed significantly across all treatments. The mean values of organoleptic score for overall

acceptability ranged from 5.3 to 8.7. The minimum organoleptic score for overall acceptability 5.3 was recorded in T_0 (Control), while the maximum organoleptic score for overall acceptability 8.7 was recorded in T_6 (Lotus stem + Green chili + Carrot + Apple vinegar).

4. CONCLUSION

Based on the statistical analysis, it has been observed that treatment T8 (Lotus stem + Green chili + Carrot + Sugarcane vinegar) was found best in terms of physico-chemical properties *viz.* pH (4.30), acidity (1.37%), total soluble solids (21.27^{o}Brix), vitamin C (14.46mg/100g), total sugar (6.31%). Based on the statistical analysis, it has been observed that treatment T6 (Lotus stem + Green chili + Carrot + Apple vinegar) was found best in terms organoleptic properties *viz.* colour (8.3), taste (8.7), flavour (8.7), texture (8.3) and overall acceptability (8.7).

This research sheds light on the untapped potential of lotus stem, demonstrating its versatility and value beyond traditional uses. By promoting the production and consumption of lotus stem pickle, we contribute to minimizing agricultural losses, fostering awareness about this nutritious vegetable and enriching culinary experiences.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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