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Standardization and Biochemical Analysis of Dragon Fruit (*Hylocereus undatus*) Mayonnaise

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ABSTRACT: Dragon fruit is considered as a super fruit with tremendous health benefits including anticancer properties. A dragon fruit mayonnaise was standardized to evaluate the biochemical properties as part of research carried out at School of Agricultural Sciences in Karunya Institute of Technology and Sciences, Coimbatore. The stability, consistency and rancidity of mayonnaise are major challenges as the major ingredients are required to be added in right amounts with the right type of blending. The treatments used in this experiment were: plain mayonnaise without egg, plain mayonnaise with egg, mayonnaise with dragon fruit and no egg, mayonnaise with dragon fruit and with egg. The biochemical properties (titratable acidity, pH, vitamin C, protein, ash, moisture and carbohydrate content) of the different mayonnaise combinations were assessed. The highest protein (34.67g/100g) and carbohydrate content (20.74g/100g) were observed in mayonnaise with dragon fruit and egg, as compared to all other treatments. Dragon fruit mayonnaise with no egg exhibited the highest vitamin C content (5.62mg/100g), which could be attributed to the presence of dragon fruit in the mayonnaise. The fat content was significantly lower in the dragon fruit mayonnaise as compared to plain mayonnaise (both with and without egg). The results indicated that the fat content is lowered due to addition of dragon fruit in the mayonnaise. Efforts are underway to develop low-calorie versions of plant-based mayonnaise with potential health benefits.

Keywords: Dragon fruit, mayonnaise, low-fat, vitamin C, antioxidants.

INTRODUCTION

Dragon fruit or pitaya (*Hylocereus* spp.) is one the recently introduced tropical fruits in India, belonging to Cactaceae family and is regarded as a promising and profitable fruit crop. The fruits are very attractive with leathery and leafy skin and have black seeds embedded in the pulp. *Hylocereus undatus*, a white pulp with pink skin fruit is cultivated for its white flesh. Cultivation of dragon fruit originated in Mexico, Central and South America (Arivalagan *et al*., 2021), and due to it tremendous nutritional and medicinal properties, it has attracted growers from all over India to cultivate this fruit crop. Dragon fruit is a long-day plant with magnificent flowers and because of its night blooming nature, it is referred as "Noble Woman" or "Queen of the Night"(Perween *et al.,* 2018).

Dragon fruit is known for its high nutritional value as it contains various nutrients, vitamins and minerals and are used for medicinal purposes (Luo *et al.,* 2014). The fruits contain vitamin C that plays a vital role in the immune function. The presence of several glycosides such as betalains, phyllocactin, hylocerenin and betacyanin are reported by Luo *et al.,* (2014) which are responsible for stimulating the antioxidants present in the system. The red-purple peel of dragon fruit is a rich source of anthocyanin having antioxidant activity which could be exploited as an ingredient in food and cosmetic preparations. According to Purnamasari *et al.* (2021), dragon fruits are an important source of phytochemicals such as polyphenols, flavonoids, and vitamin C, contributing to its antioxidant property.

Plant-based diets are gaining popularity primarily due to its health benefits, with nutraceutical and therapeutic properties. Mayonnaise is a creamy spread, which is gaining popularity among the younger generation and consumed by people of all categories along with

sandwiches, burgers, salads and French fries. It is an oil-in-water emulsion and contains about 70 to 80% fat. The high fat content of mayonnaise increases the cholesterol levels and risk of heart disease apart from making it difficult to attain storage stability and quality. The oxide interface along with the physicochemical quality attributes, determine the shelf life of mayonnaise which is ultimately co-related to oxidative stability (Calligaris *et al.,* 2007). Kwon *et al.* (2015) reported that the rate of the oxidation process in mayonnaise depends on the availability of oxygen and the presence of oxidative products. Synthetic and natural antioxidants are used in large scale production to minimize lipid oxidation and deterioration. According to Eshghi *et al.* (2014), synthetic antioxidants are being used commercially to control the oxidation of unsaturated fats.

The emulsion of mayonnaise is formulated by mixing vegetable oil with egg yolk, salt, sugar, lemon juice or vinegar, dried herbs and spices (Raikos *et al.,* 2016). Along with oil, mayonnaise also contains eggs as a common emulsifier due to their emulsifying properties which are ideal constituents in mayonnaise production. Huang *et al.,* (2016) also reported that the mayonnaise formulation is stabilized by egg yolk as it contains several proteins such as livetin, lipovitellin and lipovitellin and phosphor-lipid, lecithin. Mayonnaise is usually pale yellow or white in colour and is prepared in varying consistencies from spreading to a dipping sauce. Traditionally, mayonnaise is low in pH and is prepared in a semi-solid consistency. Stability of mayonnaise can be achieved if the different parameters like vegetable oil, egg yolk, are used in the right proportions and with the right blending (Gorji *et al.,* 2016). The aim of the study was to formulate and asses the biochemical parameters of a plant-based, reduced-fat, functional mayonnaise.

MATERIALS AND METHODS

This experiment was carried out in the Food Processing Technology laboratory of Karunya Institute of Technology and Sciences, Coimbatore during Jan 2022-May 2023. The treatments used in this experiment were:

Treatments:

Treatments	Treatment Details
T1	Plain mayonnaise
T2	Plain mayonnaise with egg
T3	Mayonnaise with 5% Dragon fruit and no egg
T4	Mayonnaise with 5% Dragon fruit and egg

A. Formulation of Dragon fruit Mayonnaise

The following ingredients were used to make mayonnaise from chicken eggs: fresh egg yolk (15 %), pasteurized milk (10 %), sunflower oil (70 %), salt (2 %), lemon juice (0.9%), pepper (1%), dry mustard (1%) and sodium benzoate (100 ppm). The components were mixed together according to Depree and Savage (2001) using an electric mixer with modifications. The eggs were pasteurized at 70°C for 2 mins and then chilled. The egg yolks were collected in a clean beaker after the yolk membrane was punctured and used to make mayonnaise. Then egg yolks were added into a mixer and blended for 5 min. To prepare the emulsion, oil was gently added while continuously mixing; once all of the oil had been added, it was again beaten for 5 min or less. The ingredients spices (powders of pepper, mustard, garlic), herbs (leaves of basil and oregano), lemon juice and salt, were combined or blended until a smooth paste was obtained. The dragon fruit was rinsed with tap water and wiped to dry. The fresh pulp was removed from the ripe fruit before being chopped into tiny pieces and 5% dragon fruit pulp was added to the remaining ingredients and mixed once again. Under aseptic conditions, the formulated mayonnaise was transferred to sterile jars and kept refrigerated for 6 weeks.

B. Biochemical analysis

The following biochemical parameters of the different mayonnaise formulations were determined: moisture, protein, fat, ash content and titratable acidity according to the approach outlined in AOAC (2005). Each test had three replicates.

Titratable acidity (%). Titratable acidity (T.A) was assessed by titrating 10 g mayonnaise to pH 8.1 with 0.1 N NaOH and converting the results to a percentage using the AOAC technique (2005).

pH measurement. A pH meter was used to measure the pH values of mayonnaise samples.

Moisture content (%). The moisture content was evaluated using the method defined by the AOAC (2005). A 5g sample was placed in a covered crucible and dried in an oven for at least 3 hours at 105°C; the oven temperature was kept constant. It was again weighed after cooling in desiccators.

Vitamin C Content (mg /100g). A sample of 5 g was extracted with 4% oxalic acid. Total vitamin C content was measured by employing standard indicator dye 2,6-dichlorophenol indophenol and the concentration was represented as mg 100 g -1 (Sadasivam and Manickam 1996).

Protein Content (g/100g). Total protein content was measured using the standard Lowry's method (AOAC, 2005).

Fat Content (g/100g). The fat content was determined using a Soxhlet equipment and petroleum ether extraction according to the AOAC technique.

Ash Content (%). The ash content was determined by using the AOAC technique, in which 5g of the sample was weighed and transferred to a crucible. After weighing the sample, it was placed in a muffle furnace set at 550°C.The sample was burnt for 4 hrs to acquire a permanent weight, until no black particles remained. Both the crucible and ash were chilled in desiccators. Finally, the crucible and ash were weighed together.

Total carbohydrate (g/100g). Total carbohydrate content was estimated based on the content of fat, protein, moisture and ash content using the following formula:

Total carbohydrate =100 – (Fat + protein + moisture + ash)

C. Statistical analysis

The data was statistically analyzed by using computerized ANOVA and completely randomized design procedures. There were 4 treatments and 3 replications. All data are shown as an average of three replicates (Panse and Sukhatme 1985).

RESULT AND DISCUSSION

The results of the biochemical properties including fat, moisture, ash, acidity, carbohydrate, protein and pH of different mayonnaise formulations were analysed and presented in tables1 and 2.

Table 1: Titratable acidity and pH of the treatments.

Formulation	Titratable Acidity (%)	pH
T1	0.56^{a}	3.51^{c}
T2	0.61^{a}	3.65^{bc}
T3	0.71^{b}	3.83^{ab}
T4	0.74^{b}	3.90^{a}
SE (±)	0.027	0.07
CD at 5%	0.089	0.24

Each value represents an average of three determinations

Mayonnaise without egg formulation (T_1) exhibited a lower pH than the mayonnaise prepared by using dragon fruit. Mohammed *et al.* (2022) reported that the pH of the mayonnaise was acidic, when lemon juice or vinegar was added. The acidic nature of mayonnaise increases its shelf life and protects its microbiological stability. Pradhananga *et al.* (2015) observed that to manufacture salmonella-free mayonnaise, the pH should be 4.1 or below (known as the safe pH value) for the safety of mayonnaise and falls within the pH range 3.90 which is considered as safe for consumption.

Titratable acidity was found to be low in T_1-without egg (0.56%) whereas more acidity was observed in T_4 - dragon fruit with egg (0.74). T_1 showed low acidity when compared to other three samples. T_3 and T_4samples contained 0.71%and 0.74 % acidity respectively which was higher and significantly different from plain mayonnaise with no eggs. Similar results were observed by Abu-Salem *et al.* (2007), where the titratable acidity increased by 0.24% in mayonnaise made from pasteurized chicken eggs.

Table 2: Chemical/nutritional parameters of Dragon fruit Mayonnaise.

Formulation	Moisture (%)	Fat (g/100g)	Protein (g/100g)	Carbohydrate (g/100g)	Ash (%)	Vit-C (mg/100g)
T1	15.29^{b}	55.16^{a}	28.98^{b}	19.75^{b}	0.32^{c}	0.00^{c}
T2	33.79^{a}	39.12^{b}	32.88^{a}	20.13^{a}	0.37^{b}	0.00^{c}
T3	34.60^{a}	38.65^{b}	33.46^{a}	20.54^{a}	0.41^{b}	5.62^{a}
T4	34.70^{a}	38.8^{b}	34.67^{a}	20.74^{a}	0.47^{a}	5.48^{b}
S.E(m) (±)	0.280	0.059	0.035	0.091	0.016	0.033
CD at 5%	0.238	0.819	0.426	0.612	0.052	0.111

Each value represents an average of three determinations

When investigating the chemical properties of mayonnaise, high moisture content was found in T_4(34.70%). T4 was significantly different from T_1, $T_2$and T_3samples. The moisture content of T_1, T_2, T_3samples were 15.29%, 33.79%, 34.60% respectively. T_1 was lowest moisture than T_2, T_3, and T_4. When the concentration of dragon fruit in the mayonnaise sample increased, the moisture content of mayonnaise also increases. According to Amin *et al.* (2014), higher moisture content of the low-fat mayonnaise diluted the colour of the sample resulting in a creamish white colour that panellists preferred over the full fat mayonnaise due to the high concentration of oil.

In this study, dragon fruit mayonnaise showed high protein content when dragon fruit pulp was added to it. T_4 (mayonnaise with dragon fruit and egg) was significantly different when compared with all other treatments and was found to contain the highest protein content of 34.67g as compared to all other treatments. The lowest protein content (28.98g) was observed in control T_1 (plain mayonnaise with no egg). A study conducted by Gaikwad *et al.* (2017) reported that the highest protein was observed in the study of physicochemical properties of flavored mayonnaise.

The dragon fruit mayonnaise was observed to have the lowest fat content when compared with all other treatments. Higher fat content of the mayonnaise was observed in T_1 possibly due to oil content and lower fat content was noticed in T_2, T_3, T_4, (39.12g, 38.65g, and 38.8g respectively). $T_1$was significantly different from the treatments T_2, T_3, T_4. Mohammed *et al.* (2022) reported that the egg free virgin coconut oil mayonnaise had a fat level of 27.5g/100g. The carbohydrate content of mayonnaise was high in T_4(20.74g/100g), T_1had the lowest carbohydrate content of all produced formulations with 19.75g/100g, the carbohydrate content of T_2 and T_3 were significantly lower.

The lowest ash content was found in treatment T_1-0.32gas compared to the other treatments. T_4 showed the highest ash content (0.47%). T4 was significantly different from samples T_1, T_2, T_3. The ash content was higher when1.5% cardamom flavour to the flavoured mayonnaise (0.34g/100g) which was more or less similar to results of Gaikwad *et al.* (2017), who also reported that addition of cardamom increased the ash content.

Vitamin C was high in T_3 when compared with all other prepared mayonnaise samples T_3 (3.62 mg/100g), due to the presence of dragon fruit which has high vitamin C content. Rahmawati and Mahajoeno (2009) have reported that vitamin C content was high in 100g of dragon fruit pulp. Vitamin C content was not found in $T_1$and T_2.Sonawane *et al.* (2017) reported that dragon fruit contained more than 3 times the amount of vitamin C found in carrots.

CONCLUSIONS

Based on the present study, it was observed that dragon fruit mayonnaise contained more protein and ash compared to plain mayonnaise. Also, dragon fruit mayonnaise is rich in Vitamin C which is significantly important for health, which and was not present in plain mayonnaise. Above all, dragon fruit mayonnaise contained reduced fat content. Developing low-fat mayonnaise has several challenges in maintaining the viscosity and stability. Acidity may be enhanced by adding lime or vinegar. The findings of this study are useful not only in providing information on the nutritional content of dragon fruit mayonnaise, but also in improving public awareness and understanding of healthy food choices.

FUTURE SCOPE

Based on the present study, it is recommended that future research should be oriented towards reducing the fat content of mayonnaise-type foods that will result in potential health benefits. Efforts are underway to formulate low-calorie variations of plant-based mayonnaise not just with added flavors, but with functional enhancements.

Author contribution. K. Jagadeeswari contributed to carrying out the experiment, gathering and analysing the data, and writing the manuscript. Libin John, Febin Shaji helped with the experiments, Dr. K.N. Satheeshan, Dr. Philip Sridhar and Dr. Ivan Wilson provided expert guidance, suggestions, and critical insights throughout the research. Dr. Jenita Thinakaran contributed to formulating and conceptualizing the research problem, providing critical feedback during experimentation and in correcting earlier drafts of the manuscript.

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Conflict of Interest. None.

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