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A STUDY OF EFFICACY OF MUNGBEAN AS AN EGG REPLACER IN FORMULATION OF MUFFINS

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Abstract: This research investigates the effectiveness of mung bean paste as an egg replacer in muffin formulation. The core objective is to study the rheological behavior of mung bean in the ratio of 1:1 and 1:1.5 which would also contribute to increase the protein content of the muffin. The results showed that the proportion of mung bean paste as an egg replacer gave significant effect on moisture content, protein, fat and texture of the muffin.

Keywords: Muffins, Mung Bean Paste, Egg Replacement.

INTRODUCTION

The market for plant-based foods is well-positioned to expand. According to a recent survey, 52% of American consumers eat more plant-based foods because they think doing so makes them feel healthier. Many factors, including consumer demand, allergen reduction, improved food safety, healthier nutritional profiles, easier handling and storage, improved functionality, lower price and lower price volatility, and environmental sustainability, are driving the food industry's growing interest in and use of egg substitutes. In contrast to the basic issues with eggs, plant-based alternatives frequently cost less and offer benefits to both consumers and producers [1].

Vegan eggs can be created using either one plant-based ingredient or a combination of ingredients to mimic the functionality of eggs. Pulses are ingredients rich in proteins, starches, and fibers, as well several health beneficial ingredients. For the purpose of creating vegan eggs, proteins derived from pulses might impart intriguing capabilities in both their natural and modified forms, such as gelling, emulsification, and foaming. Mung beans are a lesser-known ingredient, but they are starting to make appearances in CPG products (Consumer Packaged Goods). As they contain many of the same amino acids and emulsifying qualities as eggs, mung beans are the perfect substitute for eggs [2].

One of the most significant edible legume crops is the mung bean (Vigna radiata L.), which is cultivated on more than 6 million ha worldwide (about 8.5% of the world's pulse area) and is primarily consumed in Asian households. The mung bean is commonly grown in many Asian nations as well as in drier regions of southern Europe, warmer portions of Canada, and the United States due to its qualities of being a moderately drought-tolerant, low-input crop, and short growth cycle (70 days or less). The mung bean is a well-balanced source of vitamins, minerals, fiber, protein, and bioactive substances in large proportions. The mung bean is inexpensive and has a high nutritional value, making it a good option for vegetarians and those who cannot afford animal proteins [3].

The functional properties of mung beans includes protein solubility, water absorption, oil absorption capacity, foaming capacity, foaming stability, emulsifying activity and emulsifying stability. These peptide properties of mung bean protein contributes to the functionality of food processing applications [4]. The aim of this study is to perform an efficacy study on different percentage of mung bean as a plant-based alternative for egg and its effects on chemical and rheological properties of muffin.

MATERIALS AND METHODOLOGY

2.1Materials

The ingredients used in this study were all-purpose flour, baking soda, baking powder, milk, powdered sugar, eggs, Amul's unsalted butter, vanilla essence, cocoa powder, dark chocolate and mung bean. All ingredients were purchased from local market. All mung beans used in this study were obtained in one batch from a local market. The outer green coat had been removed and the beans split in half when they were obtained for this research. All chemicals and reagents used in this study were of analytical grade.

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2.2 Methodology

2.2.1 Preparation of Chocolate Muffin

Step1: Formula selection.

Initial research was done to ascertain the characteristics of the protein in muffins. The control in this study was a common muffin recipe. To make it simpler to change ingredients based on the weight of the flour during product development, the recipe utilised in this study was converted to bakers' percent.

Ingredients	Control Sample	Variant 1	Variant 2
All-purpose flour	60g	60g	60g
Sugar	65g	65g	65g
Cocoa Powder	10g	10g	10g
Baking Powder	¼ tsp	¼ tsp	¼ tsp
Baking Soda	¼ tsp	¼ tsp	¼ tsp
Egg	60g	-	-
Mung Bean Paste	-	60g	75g
Butter	40g	40g	40g
Vanilla Essence	¼ tsp	¼ tsp	¼ tsp
Dark Chocolate	30g	30g	30g
Milk	10g	10g	10g

Table 1: Ingredients used in Control Sample (CS), Variant 1 (V1), Variant 2 (V2)

Step2: Preparation of Mung bean Paste

The mung bean preparation literature was reviewed in order to create the paste that would substitute the eggs. The outer green coat had been removed and the beans split in half when they were obtained for this research. The mung bean paste was prepared by soaking the split mung beans in normal water at refrigeration temperature for 12 hours. This allowed the outer enzymes to undergo cold denaturation and therefore reduced the likelihood of an off-taste in the final product. After the mung beans were removed from the refrigerator, they were immediately weighed and made into paste by using a blender.

Step 3: Introduction of Mung bean Paste

Chocolate muffins were prepared with varying amounts of mung bean paste as an egg replacer in order to determine what level of mung bean paste should be used in sensory testing. To determine optimum levels of egg replacement, the muffins were tasted by postgraduate students and department staffs. Based on inputs it was determined to test mung bean paste as an egg replacer in the ratio of 1:1 (V1) and 1:1.5 (V2). The control Sample contained no mung bean paste. The following procedures were used in making of chocolate muffins

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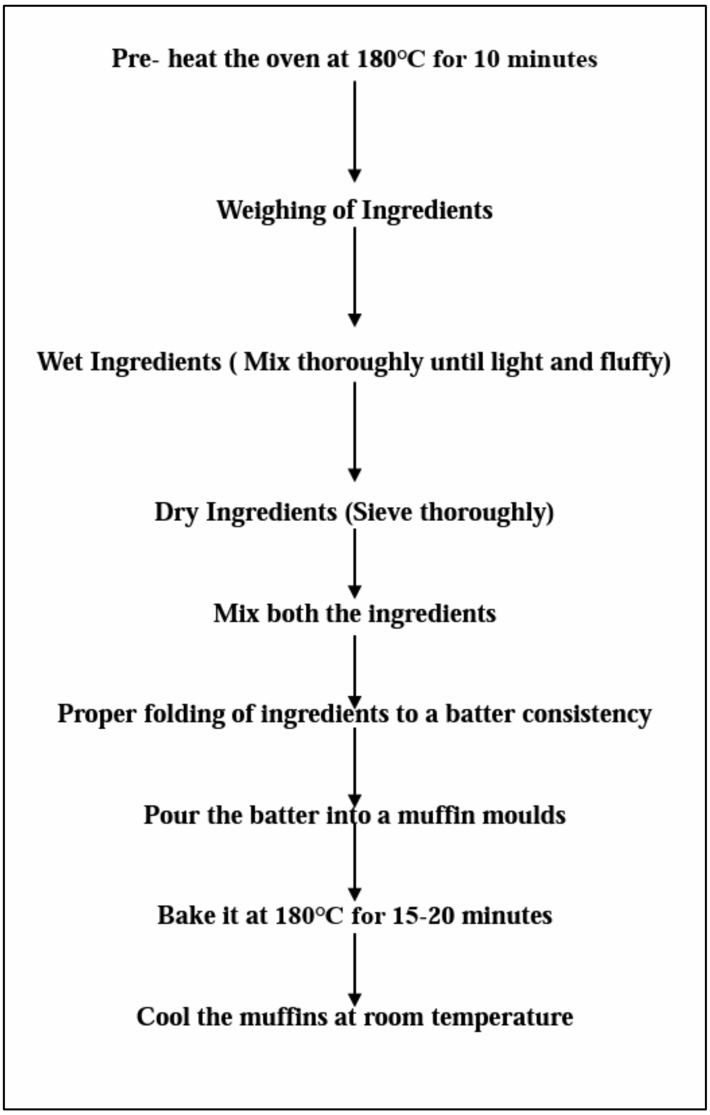

Figure 1: Procedure for Muffin Formulation

2.2.2 Proximate Analysis:
Proximate parameters: Moisture, Protein, Fat, Ash, of Muffin samples were determined. All the analysis were carried out in triplicates.

Moisture: The drying oven method is a thermogravimetric method (loss on drying) in which the sample is dried for a defined period of time at constant temperature. The moisture content is determined by weighing the sample before and after drying and determining the difference.

$$\%\text{Moisture} = \frac{\text{Loss in moisture}}{\text{Initial weight of the sample}} \times 100$$

Ash: An Ash test involves taking a known amount of sample, placing the weighed sample into a dried / pre-weighed porcelain crucible, burning away the polymer in an air atmosphere at temperatures above 500°C, and weighing the crucible after it has been cooled to room temperature in a desiccator.

% ASH = (ashed wt.) - (crucible wt.)) x 100 / (crucible and sample wt.)

Protein: The Kjeldahl method is recognized by Codex Alimentarius. The Kjeldahl method involves a three-step approach to the quantification of protein: digestion, distillation, and titration. Digestion of organic material is achieved using concentrated H_2SO_4, heat, K_2SO_4 (to raise the boiling point), and a catalyst (e.g., selenium) to speed up the reaction. This process converts any nitrogen in the sample to ammonium sulfate. The digestate is neutralized by the addition of NaOH,

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which converts the ammonium sulfate to ammonia, which is distilled off and collected in a receiving flask of excess boric acid, forming ammonium borate. The residual boric acid is then titrated with a standard acid with the use of a suitable end-point indicator to estimate the total nitrogen content of the sample. Following determination of the total nitrogen, the use of a specific conversion factor is needed to convert the measured nitrogen content to the crude protein content. Most proteins contain 16% of nitrogen, thus the conversion factor is 6.38.

$$\textbf{Protein (\%, w/w)} = \textbf{N (\%, w/w)} \times 6.38$$

Fat: The crude fat content can be conveniently determined in foods by extracting the dried and ground material with petroleum ether or diethyl ether in Soxhlet extraction apparatus.

$$\text{Crude fat, \% by mass} = \frac{(M_1 - M_2) \times 100}{M}$$

Where, M1 = mass, in g, of the Soxhlet flask with the extracted fat,
M2 = mass, in g, of the empty Soxhlet flask, and
M = mass, in g, of the material taken for the test.

2.2.3 Functional Properties

Water and Oil Absorption Capacities:

The water and oil absorption capabilities were measured using a procedure outlined by Carcea-Bencini (1986). Six dry and sterile centrifuge tubes were filled with one gramme of mung bean paste each. The labels on the tubes for water and oil were different. The next step involved adding 10 mL of distilled water to three tubes and 10 mL of oil to the remaining three. Next, each tube was manually swirled. After standing at ambient temperature for half an hour, the mixture was centrifuged for half an hour at 1500 rpm. Following the decantation of the supernatant, the volume in the measuring cylinder was recorded and multiplied with the densities of the oil (0.902 g/mL) and water (1 g/mL) to determine the weight (in grammes).

Emulsion activity (EA) and emulsion stability (ES)

A calibrated centrifuge tube containing 1 g of sample, 10 mL of distilled water, and 10 mL of gingelly oil was used to prepare the emulsion in the current investigation, which was prepared according to the emulsion activity and stability by Yasumatsu et al. (1972). The mixture was centrifuged at 2000 × g for 5 minutes. Emulsion activity, expressed as a percentage, was computed as the height of the emulsion layer divided by the height of the mixture overall. After the emulsion was heated for 30 minutes at 80°C in a water bath, cooled for 15 minutes under running tap water, then centrifuged for 15 minutes at 2000 × g, the stability of the emulsion was evaluated. The height of the emulsified layer divided by the overall height of the mixture yielded the emulsion stability reported as a percentage.

Foam capacity (FC) and Foam stability (FS)

The foam capacity (FC) and Foam stability (FS) by (Narayana and Narsinga Rao 1982) were determined as described with slight modification. 5.0 g of mung bean paste sample was added to 50 mL distilled water at 30 ± 2 °C in a graduated cylinder. The suspension was mixed and shaken for 10 min to foam. The volume of foam at 30 s after whipping was expressed as foam capacity using the formula:

$$\text{Foam capacity (\%)} = \frac{\text{Volume of foam AW} - \text{Volume of foam BW} \times 100}{\text{Volume of foam BW}}$$

Where, AW = after whipping, BW = before whipping

The change in foam volume after standing for 15 and 20 minutes at room temperature was used to measure the foam stability. The stability was calculated by using the following equation:

$$FS = \frac{V_t \times 100}{V_0}$$

where Vt = foam volume at time t, and V_0 =initial volume of the dispersion

2.2.4 Sensory Evaluation

The sensory properties of muffin were evaluated using twenty trained panelists consisting of Post Graduate students from the Department of Food Science, MOP Vaishnav College for Women, Chennai. Muffins were evaluated for crust color, flavor, taste, texture, appearance and overall acceptability using five-point Hedonic scale (where 5= liked extremely and 1= disliked extremely). A Muffin from each blend was presented to panelists. Each panelist was provided with a glass of

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drinking water to rinse the mouth between evaluation.

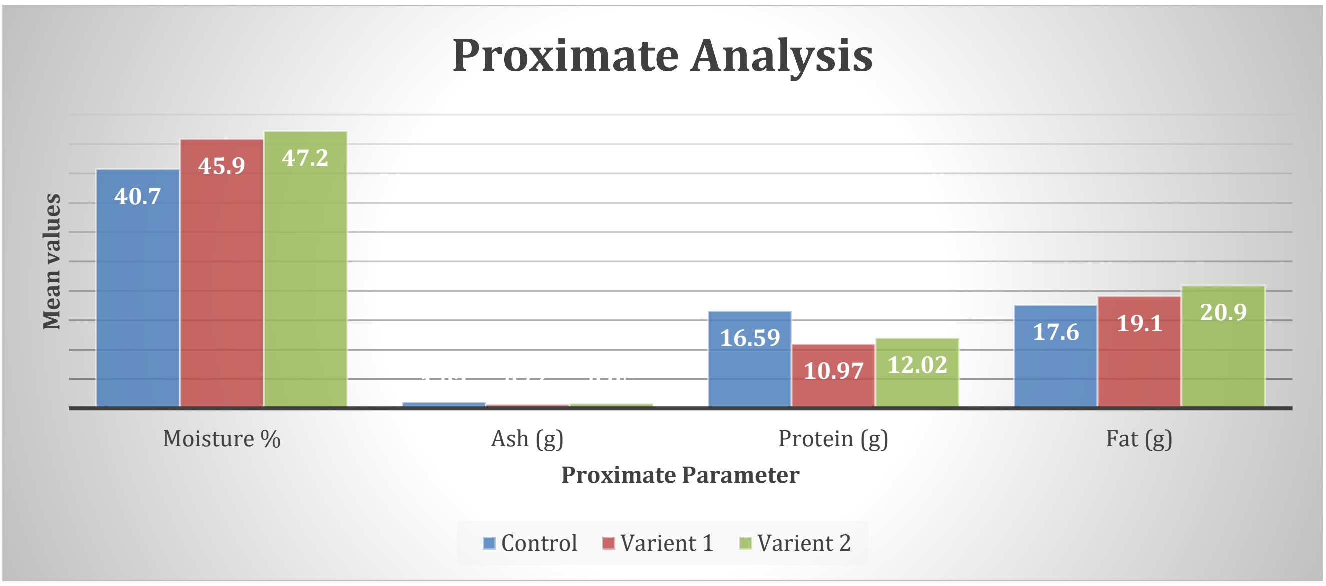
RESULT AND DISCUSSION

3.1. Proximate Analysis

The proximate analysis results are shown in table 2. The moisture contents were highly influenced by addition of mung dal foam as that control sample had (40.7%) moisture and the mung muffins (45.9-47.2%) moisture was observed. Ash content there is a slight increment in ash content, as compared to the control (1.02%) and sample (0.66-0.85%). Protein the most target nutrient in the current research was higher in both control sample (16.59) and mung dal muffins (10.97 - 12.02). Though it is not to the protein level of egg made control muffin it can serve as a good source of protein to meet the basic nutrient requirement. The amount of protein in mung dal muffins (9.29- 9.86g) the control sample protein (10.97g). The total lipid contents of sample muffins (19.1-20.9 g) exceeded that of control muffins (17.6g).

Samples	Moisture %	Ash (g)	Protein (g)	Fat (g)
Control	40.7	1.02	16.59	17.6
Variant 1	45.9	0.66	10.97	19.1
Variant 2	47.2	0.85	12.02	20.9

Table 2. Proximate Analysis of the muffin samples and control



Graph.1. Proximate Analysis Results

3.2 Functional Properties

Water absorption capacity (WAC) or oil absorption capacity (OAC) is defined as the absorbed amount of water or fat per gram of flour. One of the factors affecting WAC and OAC values is protein content of foodstuffs [11]. Protein has both hydrophilic and hydrophobic properties to interact with water and oil in foods. WAC indicates the hydrophilic capacity of the protein while the OAC can indicate the hydrophobic capacity of the protein. WAC and OAC were used to indicate protein ability in the food material to prevent fluid loss from a product during food storage or processing [12].
The WAC and OAC of Mung bean Paste are 3.23 and 3.01. The high-water absorption capacity of mung bean paste makes it desirable for use in bakery products. The capacity of flour to absorb and hold onto water or oil can increase the flavour, texture, and mouthfeel of food products, as well as minimize moisture and fat loss in baked goods.

Emulsifying activity is the ability of protein to form emulsion. As shown in Table 3, the EA of mung bean paste in distilled water is found to be 62.8%. The emulsion stability is the measure of the steadiness of emulsion formed by protein. The emulsion stability is the measure of the steadiness of emulsion formed by protein. The emulsion stability of mung bean paste is around 61.32%. Emulsifying activity and stability are critical factors in bakery products.

The foaming capacity of a protein is measured as the amount of interfacial area that can be created by whipping the protein. Foam stability is defined as the time that foam will maintain its initial properties as generated.

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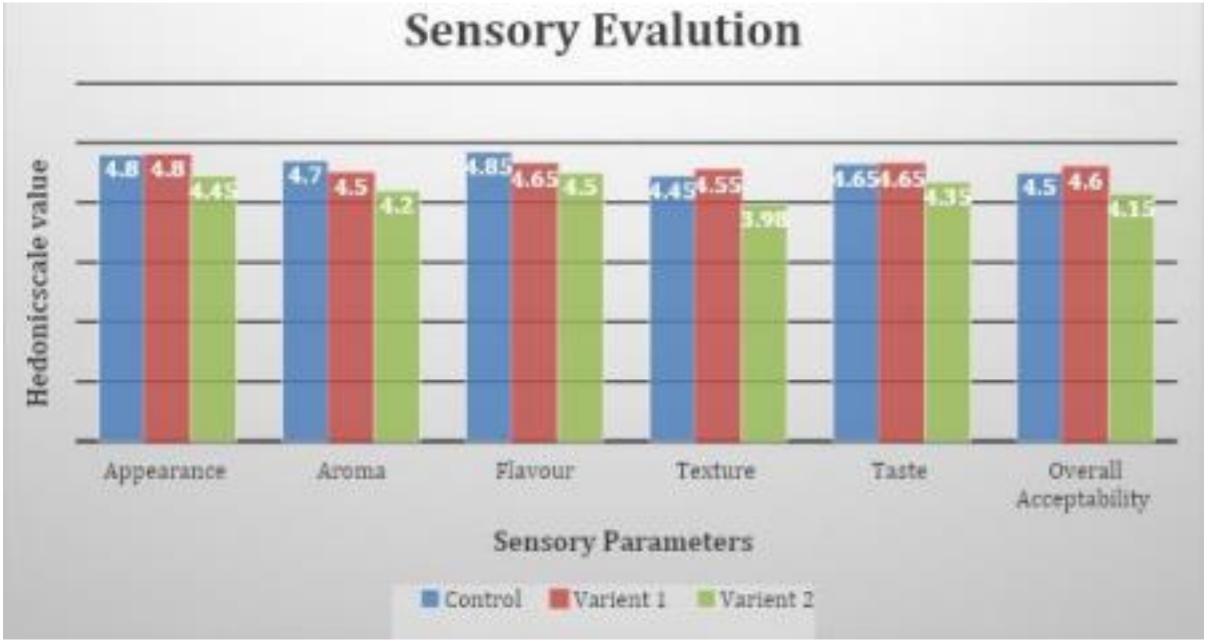
Functional Properties	Mung Bean Paste
Water Absorption Capacity (g H_2O / g Protein)	3.23g
Oil Absorption Capacity (g Oil / g Protein)	3.01g
Emulsion Activity (%, in distilled water)	62.8%
Emulsion Stability (%, in distilled water)	61.32%
Foam Capacity (v/v), %	88.01%
Foam Stability (v/v), % Standing time, 15 mins 20 mins	 79.7% 77.7%

Table.3 Functional properties

3.3 Sensory Analysis

Panelists evaluated the sensory properties of the bread samples based on their degree of like (scale of 1-5) where1 = dislike very much, 2 = dislike slightly, 3 = neither like nor dislike, 4 = like slightly, 5 = like very much. The sensory attributes which were evaluated were appearance, flavor, aroma, texture, taste and overall acceptability. Graph 2 summarize the mean scores of hedonic sensory evaluation of appearance, flavor, aroma, texture, taste and overall acceptability of control and mung bean muffins. As can be seen, substitution of egg with mung bean paste of 50% and 75 % had a significant effect on all sensory parameters of the muffin samples. The overall acceptability of the control and muffin samples are similar, that is high. But the muffin sample with 75% of mung bean paste shown significantly lower score on texture i.e., it was crumbly.



Graph.2. Sensory Analysis Results

CONCLUSION

Our study concludes that muffins made by the incorporation of mung bean paste as an egg replacer showed most satisfactory results in both sensory and nutritional aspects as there was a notable increase in the protein contents and total lipid contents. The ratio of 1: 1 ratio of all-purpose flour and mung bean paste is found to be best among all of them in flavor and overall acceptability but according to nutritional value, 1:1.5 proportion of all-purpose flour and mung bean paste increased the most protein contents.

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