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Plant Marrow with Gluten Meat as an Alternative to Animal Meat

Research Article

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Abstract

Increasing inclination towards vegan and vegetarian foods has led to the development of plant-based meat products. Bone marrow of meat is generally consumed by non-vegetarians for its nutritional value. As this is difficult for vegetarians, this study aimed to develop a plant marrow (corn cobs) incorporating oyster mushroom, roasted cashew nut, wheat gluten, and spices. The plant marrow was evaluated in three trials and tested for its proximate composition and sensory characteristics. Proximate analysis revealed the presence of 20.6% protein, 2.8% fat, 4.2% fibre, 7.0% moisture, 8.5% ash, and 56.8% carbohydrates in the final product.This indicated a well-balanced nutritional profile compared to natural animal meat. Sensory evaluation by an untrained panel provided high mean scores for appearance (7.55), taste (8.1), aroma (8.5), and texture (7.8), reflecting high consumer acceptability. Hence, this product can be considered a meat alternative for health-conscious consumers. Further studies can enhance the acceptability and texture of this food product along with efficient methods for packaging and increasing the shelf-life.

Keywords: Plant Marrow; Corn Cob; Plant-Based Meat; Vegetarian; Oyster Mushroom

Introduction

The terms vegetarians and vegan trace their roots to the ancient Latin word 'vegetus', meaning healthy and vigorous. Vegetarianism excludes meat, fish, and their derivatives, whereas veganism is a stricter form and eliminates all animal products.Driven by ethical, environmental, and health concerns, plant-based diets have gained significance. Interestingly, the market for plant-based proteins is gaining huge popularity and is being followed worldwide. Since the bone marrow of meat is rich in fats, it could lead to the onset of overweight, obesity, and other diseases. The rise of meat alternatives, such as plant-based meat analogues, has fuelled the trend [1, 2, 3] of consuming them. Meat analogues are plant-based food products that resemble meat regarding sensory qualities [4, 5, 6]. The major concern of plant-based meat analogues is food safety, as these products are easily susceptible to microbial contamination. Overall, the growing demand for sustainable and ethical food choices has led to the emergence of plant-based meat analogues. The analogues, mentioned in this study aim to replicate the taste, texture, and appearance of real meat by replacing the meat marrow with corn cob marrow.

Materials and Methods

Preparation of plant marrow

The corn cobs and other ingredients required for the study were procured from the local market. The corn cobs were washed thoroughly, and the outer layer was removed using a sharp knife and later polished. The inner core of the cob was scooped out and dried in an oven at 105°C for 20 minutes.

Preparation of plant marrow stuffing and gluten meat

The stuffed ingredients were mixed and sautéed for 10 minutes on low flame. This mixture was then blended into a fine paste using an

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electric blender and stuffed into the hollow corn cobs (plant marrow). To imitate the visual appearance of animal meat, gluten flour was mixed with corn starch and spices. This mixture was extruded using an extrusion machine to the desired shape and rolled around the plant marrow. This product was packed in air-tight containers and stored at -18°C for further studies. Meanwhile,some of this product was shallow fried using refined oil and subjected to sensory evaluation.

Three trials were performed with variations in the stuffing of the plant marrow. Trial 1 consisted of button mushrooms, eggplant paste, salt, pepper, and coconut oil. Trial 2 consisted of oyster mushrooms, drumstick pulp, spices, and agar agar. Trial 3 consisted of oyster mushrooms, roasted cashew nuts, and spices.

Assessment of the product

Sensory evaluation of the product was performed using a rating card on a 9-point hedonic scale,wherein 1: dislike extremely to 9: like extremely [7]. 30 Panellists were selected randomly and asked to taste and rate the product unanimously.

Proximate analysis of the product

The moisture, protein, fat, ash, and vitamin B2 and B3 contents of the food sample were determined in the proximate analysis.

Moisture content was evaluated by evaporation method. Samples were placed in an oven for 3 hours at 105°C. The weights of the samples were measured before and after placing them in the oven. Protein was calculated using the Kjeldahl method. The Kjeldahl method involved placing a weighed sample of food product into the digestion flask and digesting it with sulphuric acid, anhydrous sodium sulfate, and any catalyst (copper salt). After digestion, the solution is made alkaline by adding 40% sodium hydroxideto convert ammonium sulphate to ammonia gas. This gas is mixed with boric acid and titrated with an indicator to detect the endpoint [8].

The fat content of the food product was determined by the Soxhlet method. The food product was dried, ground into small pieces, and placed in a porous thimble. This thimble was placed in an extraction chamber suspended above a solvent, and a Soxhlet was carried out. At the end of the process, lipids remain in the flask, and the solvent is removed by evaporation [9].

Ash content was estimated by sample incineration at high temperatures (500°C to 600°C) in a muffle furnace [10].

Fibre content was estimated by considering 2.5g of moisture-free sample in a Soxhlet flask, and 200ml dilute sulphuric acid was boiled and added to this. This mixture was refluxed and heated until boiling was seen. The flask was rotated frequently, taking care that the material would not stick to the sides of the flask and not to keep the material out of contact with the acid. This boiling was carried out for 30 minutes and later filtered using linen. The filtrate was washed with boiling water to remove the acidic content. Further, it was washed in boiled sodium hydroxide for 30 minutes. Again, the mixture was filtered, and the filtrate was washed with hot water, followed by 15 ml of ethyl alcohol in the crucible with a lining of ignited asbestos. The crucible contents were dried at 105°C in a hot air oven and cooled to be weighed. The contents were incinerated in a crucible at 600°C. The ash obtained from this was cooled and weighed again using the formula crude fibre (percent by mass) = 10000 (M1-M2) M * (100 – W) where M1 is the mass of the crucible and contents before ashing, M2 is the mass of crucible with asbestos and ash, M is mass of material taken for test, and W is the percentage of moisture [9].

Vitamin B12:The estimation of vitamin B12 was carried out by standard protocols (Hung et al 1999). Vitamin B12 was prepared as a working standard at 26.2 mg per 100 ml (10 µg of cobalt). This was aliquoted in different concentrations from 2.5 to 17.5 µg/ml (of cobalt). Similarly, samples were also considered at these concentrations, and the same procedure was followed. Absorbance was recorded at 435 nm, and a standard graph was plotted [11].

Finally, a comparison test was performed between natural meat (animal source) and plant-based meat (plant marrow). Both samples were subjected to the same tests as mentioned earlier.

Statistical analysis

The statistical tests for the sensory evaluation were carried out to determine values such as mean, standard deviation, and residuals. The ANOVA test was applied to identify the p-value and test the hypothesis at the 0.05 significance level. A Q-Q plot was plotted to test the deviation of the data from the mean values.

Results and Discussions

Sensory evaluation

The results of preparing the plant marrow and using three different stuffing'swere evaluated by random individuals by sensory tests. According to the hedonic scale responses and comments from the sensory evaluation, trial 1 had more of a nutty flavour with an unpleasant consistency. Trial 2 had a slightly bitter taste and altered the flavour and texture. However, trial 3 had a satisfactory taste, flavour, and texture. The gluten meat made of corn starch and wheat gluten had an acceptable meat consistencyand chewy texture. The overall appearance of the final product was also appreciated as it imitated the control set considered in the study.The flowchart of the product development is mentioned in (Figure 1, 2).

The values of various parameters studied in the proximate analysis is depicted in (Table 1). The protein content was observed to be highest, at 20.62g per 100g serving.

The observations of comparison from animal meat and plant-based meat products (per 100g) are mentioned in (Table 2)A clear indication of decreased calories and fats is observed, along with increased fibre content.

Table 1: Results of proximate analysis on plant marrow.

Nutrient Parameter	Content (g/100g)
Moisture	7.0
Protein	20.625
Fat	2.8
Fibre	4.2
Ash	8.5
Vitamin B12	0.0035

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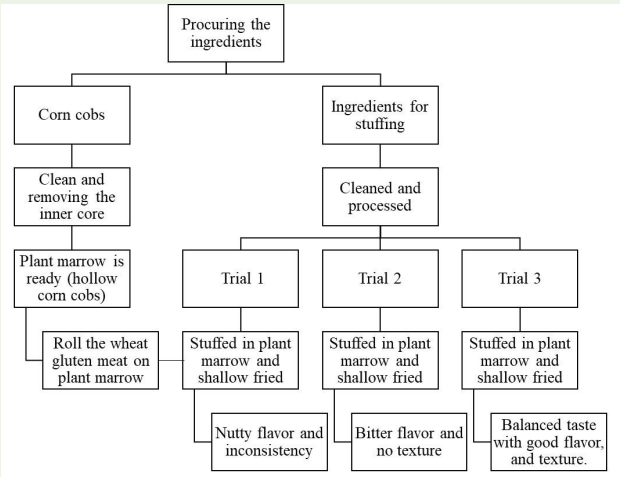

Figure 1: Flowchart of the procedure followed in developing the plant marrow. Three trials involved in optimizing the stuffing used for plant marrow and the observations made are mentioned in this flowchart. Incorporating the gluten meat around the plant marrow for aesthetic appeal is also included in the flowchart.

Figure 2: The making of plant marrow and comparison with the control. a: Corn cobs cleaned and prepared for stuffing, b: corncobs filled with different types of stuffing, c: imitation of the meat, made from wheat gluten and corn starch, d: final product (shallow fried plant marrow and wheat gluten), e: control sample for comparison..

Proximate analysis

Statistical analysis

The mean values calculated from each parameter in each trial are shown in (Table 3). The ANOVA study revealed the p-value of the observations in all parameters to be lesser than 0.05, i.e., 95% significance level of alpha (Table 4). Hence, we reject the null hypothesis (assuming the average of all the groups is equal)for all the parameters. The Q-Q plot of the same data is plotted and shown in (Figure 3). It is evident from the Q-Q plot that the data points closely follow the mean value (straight line) and do not deviate much from the straight line, indicating a good distribution.

Conclusion

The three trials to decide the stuffing demonstrated the importance of selecting appropriate ingredients for overall acceptability. In the

Table 2: Results of comparison between animal meat and plant marrow (plant-based meat).

Parameter	Control sample	Plant marrow
Calories	700kcal	334.9kcal
Carbohydrates	0g	56.8g
Protein	7g	20.625g
Fat	75g	2.8g
Fibre	0g	4.2g
Vitamin B12	0.001g	0.0035g

Table 3: The mean values from sensory evaluation of three trials of food product.

Parameters	Appearance	Taste	Aroma	Texture	Overall Acceptance
Trial 1	6.60	6.7	7.0	6.9	6.7
Trial 2	6.65	7.2	7.2	7.2	7.0
Trial 3	7.55	8.1	8.5	7.8	8.15

Table 4:P-values from the ANOVA analysis of appearance, taste, aroma, texture, and overall acceptance.

Parameters	Appearance	Taste	Aroma	Texture	Overall Acceptance
p-value	0.002	0.0002	0.0008	0.00008	0.00002

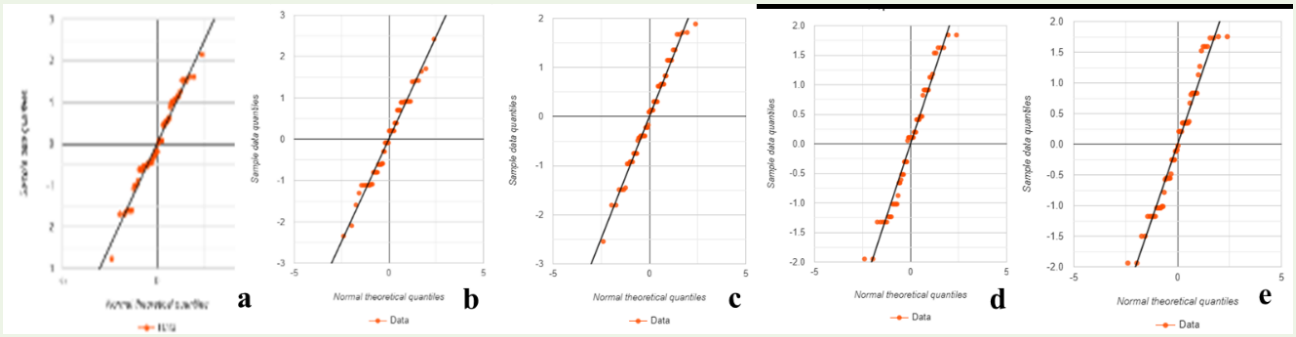

Figure 3: The Q-Q plot of parameters considered in sensory evaluation. The plot was constructed using the online website statistics kingdom [10]. The data of sensory evaluation is scattered around the mean (straight line). The data is of the five parameters of sensory evaluation i.e.
a) Appearance; b) Taste; c) Aroma; d) Texture; e) Overall acceptance.

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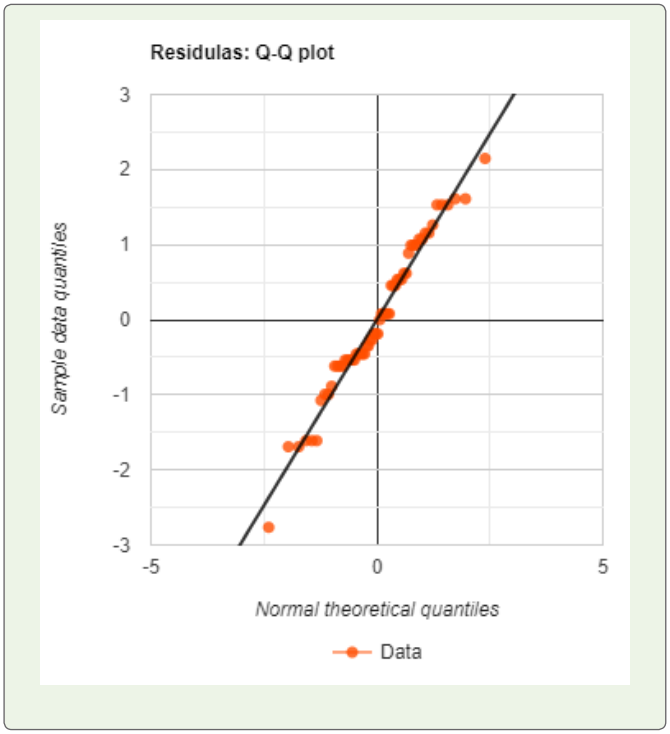

first trial, their flavourdominated due to the coconut oil and cashew nuts. In the second trial, the drumstick pulp and agar agar did not complement each other, leading to bitterness. The third trial had a balanced composition of ingredients (spices and roasted cashews), and hence, a well-balanced taste profile was achieved. Adding corn starch to the outer covering improves the consistency and appearance of the fake meat. The added spices improve the flavour and make the food more palatable. Zhang, 2023 have also summarized the production, functions and limitations of plant-based meat products. The authors have recommended on the usage of wheat gluten for mimicking meat [13, 14]. Though other studies [15-17] have attempted in the production of plant-based meat from various sources, numerous ingredients have been utilized in the production of such meat. Whereas here, fewer ingredients are used to produce a meat analogue. Thus, this is an innovative food product obtained from the combination of two different major ingredients working together to offer an exquisite experience. The future of plant-based foods looks promising by addressing consumer preferences, overcoming technical challenges, and prioritizing food safety. However, rigorous food safety practices are essential to ensure the quality and safety of these alternatives.

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