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Conduction and evaluation of the sensory analysis using principal component analysis in Fizz Biosystemes software for plant-based meat

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Abstract
In the current decade, there is a rising interest and demand for the consumption of vegan meat and meat analogue like none in the trends of food consumption. Consumer acceptance is considered as vital for any new product development. The main objective behind this study is to develop plant-based meat using non-meat ingredients which have potential health and environmental benefits. Fizz biosystemes is a sensory analysis software, which helps in conducting sensory analysis in a systematic way through online mode, obtained data could be interpreted through multivariate analysis like PCA, this study focuses on the interpretation of sensory data through principal component analysis. The PCA results by judges or products on attributes showed that acceptance of samples 30% RJF 30% BF and 60% BF was having a positive relationship. These findings show how quantitative descriptive analysis may be used to determine and measure the attributes of plant-based meat products that are essential for customer acceptance.

Keywords: *Plant-based meat, non-meat ingredients, sensory analysis, fizz biosystemes, principal component analysis*

1. Introduction
According to GFI, India has a huge demand for the consumption of plant-based meat, considering the future price value and population, they have a chance of hitting the market. The advantage of this transition gives an enriched source of nutrients and proteins (Arora, Brent, and Jaenicke, 2020) [1]; and also, it avoids the release of greenhouse gas from the rearing of livestock animals (Jiang *et al.*, 2020) [7]. The sensory qualities of meat in terms of appearance, texture, flavor, and aroma play a vital outcome in customer acceptance. Meat and meat-based products play an important role in human diet due to their high protein content (Font-i-Furnols and Guerrero, 2014) [5]; Shifting to sustainable meat improves one's health and well-being; other key aspects of meat alternatives include reduced greenhouse gas emissions, food security, animal welfare, and the nutritional value full filled from the inclusion of various non-meat ingredients (Kumar *et al.*, 2017) [8]. The major shift required towards sustainable meat is required to maintain and balance the emerging market demand for animal and animal products and also to satisfy flexitarians and preferential meat-eaters (Fiorentini, Kinchla, and Nolden, 2020) [4]. Mushrooms, soy, gluten, and legumes or pulses, such as chickpea, lentils, or pea, are all common ingredients in plant-based meats. The addition of these nutrients provides a higher quantity of dietary fiber, which aids in the reduction of LDL cholesterol, as well as a protein-rich source (Thavamani, Sferra, and Sankararaman, 2020) [10]. Plant-based diets have been associated with a higher risk and incidence of chronic degenerative diseases such as heart disease, metabolic syndrome, type 2 diabetes, and cancer. Low-sugar, low-saturated-fat, and low-salt diets, as well as increased consumption of fruits, vegetables, low-fat dairy products, healthy lipids from plant oils, or seafood, all contribute to reducing the risk of chronic diseases (Iriti, Varoni, and Vitalini, 2020) [6]. Consumer acceptability is directly linked to food sensory qualities or degree of product liking. The hedonic scale is primarily used to fully understand the acceptance of the developed products and how the product is accepted with respect to processing and formulation (Fiorentini, Kinchla, and Nolden, 2020) [4]. PCA was used to evaluate variables of human perception, personality, or behavior by reducing a large number of data points to a smaller number of data points using the principal component with an eigenvalue larger than 1. They employed the

PCA approach to determine the sensory profiling of the data, as well as a matrix of the mean using the product-by-attribute scores (Dettmar, Peltier, and Schlich, 2020) [2]. Mustard pungency and ally-isothiocyanate content were assessed for sensory qualities and chemical analysis, with panelists using fizz biosystems software to work on the time-intensity approach, which was used to reduce the influence of the panelist (Eib *et al.*, 2020) [3]. When observing, tasting, smelling, touching, or listening to different stimuli of the food product (Sample), the human becomes a measurement instrument requested to quantify, compare, or evaluate what they have individually felt towards the provided sample. Sensory panelist members play a major role in developing, designing, and implementing the optimization of the product, based on the gathering and computation of the feelings of a large number of people, requires a strict environment and appropriate software, including session organization, data collecting, storage, and result computing, in order to produce precise results. Fizz biosystemes is the sensory software that is being used in sensory science in order to conduct various functions in quality control, research and development, and marketing. The main objective of this study is to identify the relationship between individual preference among various sensory attributes of the sample with the help of principal component analysis.

Method

Sample Preparation

The plant-based sausage was made with various plant-based ingredient compositions like raw jackfruit (RJF) and banana floret (BF), and three different meat analogs (60% RJF, 60% BF, and 30% RJF 30% BF) were prepared and evaluated by comparing the developed sausage to control as chicken sausage. The sausage was cooked by steaming, packed, and stored at -18°C in a deep freezer. Before conducting the sensory analysis, the sausage was thawed, cut, and shallow fried, and served.

Consumer Sensory Evaluation

The sensory analysis research was carried out in a small-scale sensory lab using sensory analysis software fizz biosystemes. Each sample had a product code on it (RRJ, YVB, YAC, RIG). All of the samples were placed on a plastic plate and examined in the sunlight at midday. Sensory testing was performed on cooked sausage with temperatures ranging from 35°C to 40°C. In order to determine the ultimate acceptance of the product, a sensory test was undertaken using semi-trained panelists in accordance with IS:6273. Post-graduate and Ph.D. students from IIFPT, Thanjavur, India, took part in the test. There were a total of 25 panelists, with 9 men and 16 women ranging in age from 23 to 32. Before the sensory analysis, all of the panelists were told to rinse their palates with water in between each test sample, and each of the qualities was discussed. Color, taste, flavor, chewiness, and general acceptability were all evaluated on a 9-point hedonic scale (1- extremely dislike to 9- extremely like).

Statistical analysis

Sensory analysis was conducted in the Fizz Biosystemes acquisition software version 2.51C to build and run sessions and forms, whereas the Statistical analysis was conducted using Fizz calculations software version 2.61A to prepare and compute the statistics and graphs. The statistical method multivariate analyses using P.C.A analysis Products/Attributes with a number of sessions 25.

Sensory and Principal component analysis

Sensory Analysis

The whole process of sensory analysis was categorized into three steps: the initial step is Build sessions, the second step is collection of the simulated results and the third step is the computation of the obtained results statistically. The following are the procedure involved in Fizz acquisition software and shown in figure 1,2 and 3;

Step 1: Start Fizz Acq web and create new sessions

Step 2: Create page list and required test of sensory analysis was added, and also profile test descriptive monadic profile was added

Step 3: After profile addition, 9-point hedonic scales were provided, required number of attributes were added in the dialog box

Step 4: Next option to continue was organization, under organization Judge list with uploaded for 25 semi-trained panelists, sample name was provided and after each step save modification was given

Step 5: Next step is initializing the file, by clicking the button ‘‘ok’’

Step 6: The final step was parameter under this option codes for the sample were given alphabetical and were the addition of attributes like color, flavor, taste, chewiness and overall acceptability was given, each step should be provided with file description and saved

Step 7: We can verify the session by clicking session verification and consequently checked for errors, finally the simulation link will be generated for the hedonic test, the same link was circulated among the panelist members

Step 8: Coded sample was provided to the panelist and sensory evaluation was carried out and all the respective sessions score were entered through a link generated.

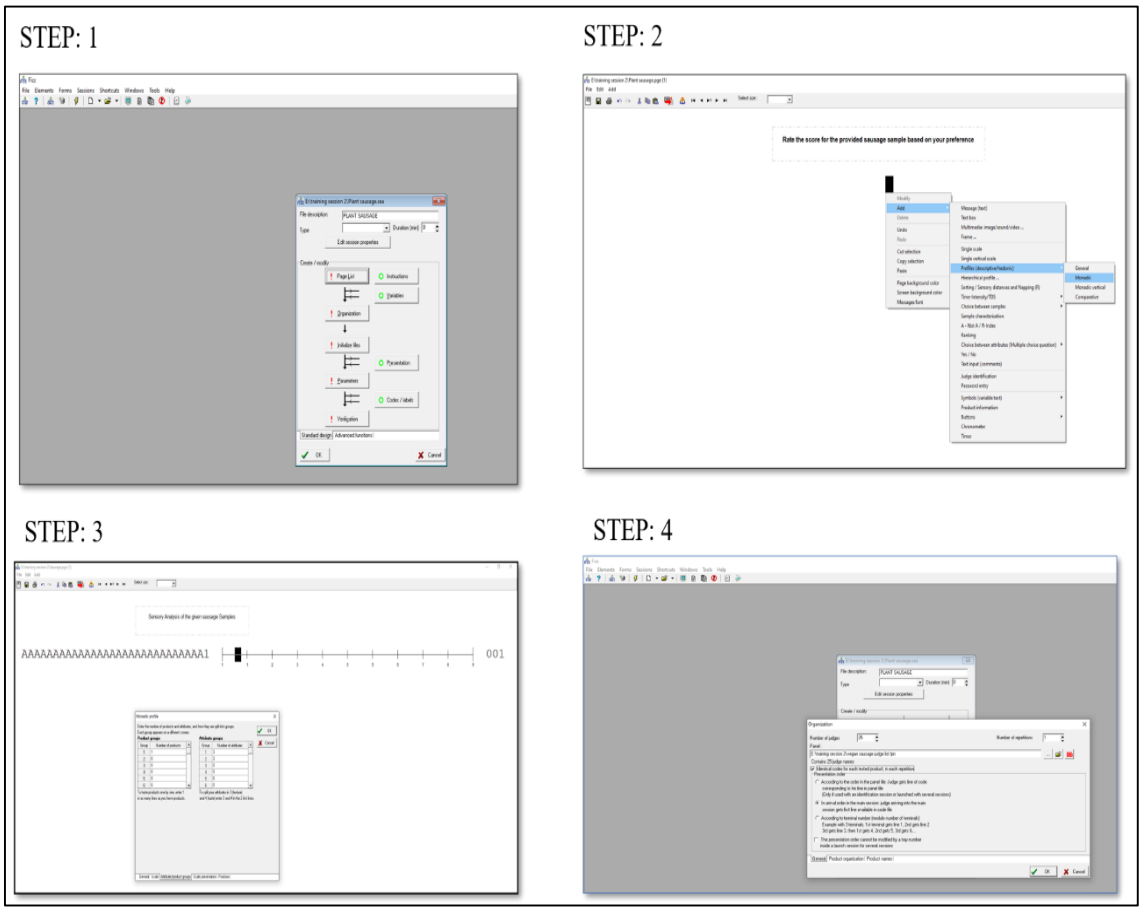

Fig 1: Steps in sensory evaluation using Fizz Acq software

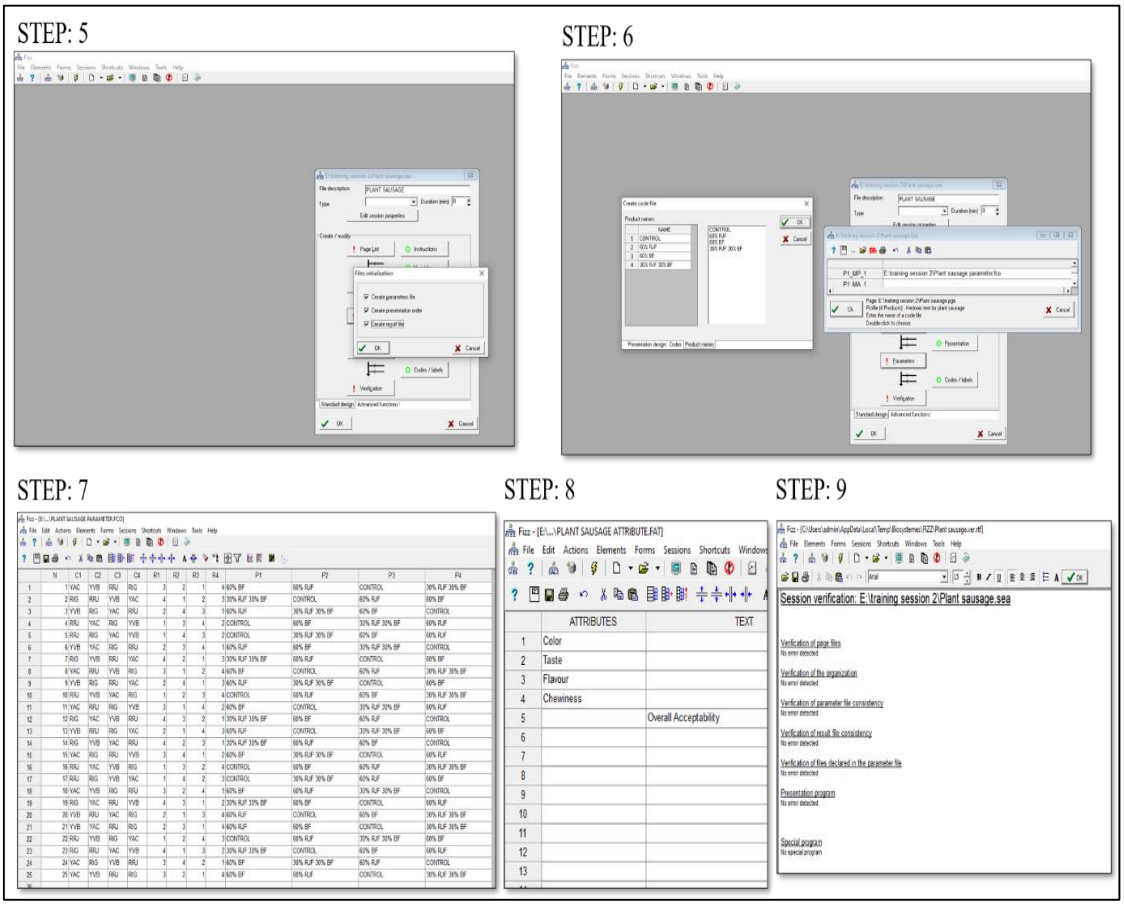

Fig 2: Steps involved in Fizz Acq software

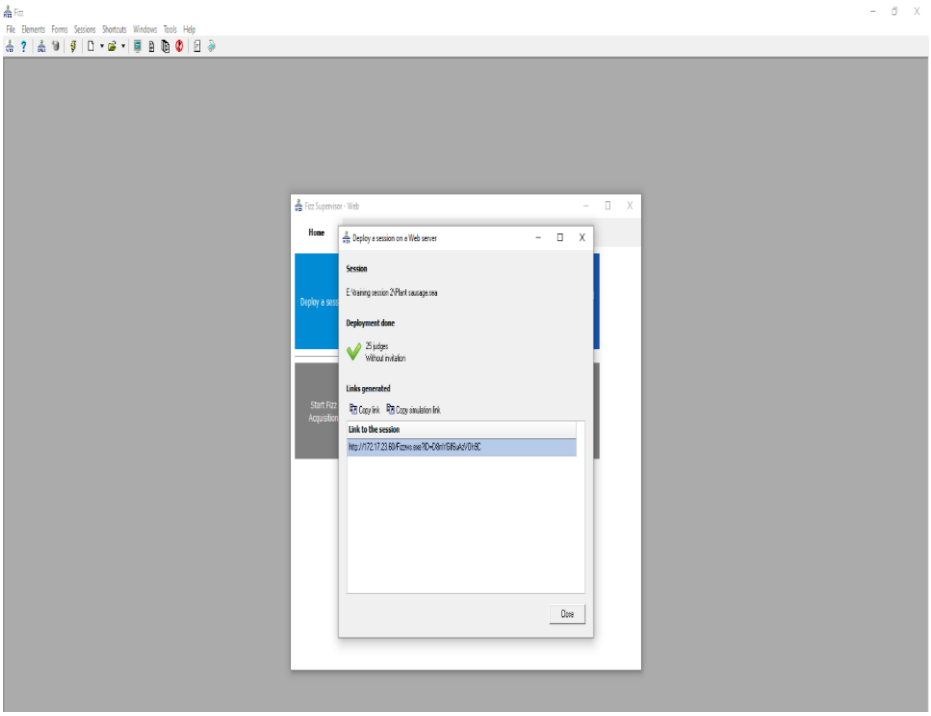

Fig 3: For sensory evaluation stimulation link generation step

Results and Discussion

Principal Component Analysis

PCA is a commonly used multivariate analytical statistical technique for reducing the set of dependent variables (i.e., attributes like color, taste, flavor, chewiness, and overall acceptability) to a smaller set of underlying variables (called factors) based on patterns of association among many of the set of variables (Lawless, Heymann, and others, 2010) [9]. The following method was used to run PCA on the plant-based sausage. After scoring on the Hedonic rating scale with fizz biosystems software, data was collected from the semi-trained panelists using fizz calculations. After that, data analysis was used to reduce the data, the independent and dependent variables were chosen, and a two-dimensional figure of the sample was created (Figure 4). PCA was conducted and the first two-component accounted for the variance of 99.5%, where the First component (FC) had 97% variance, the second component (SC) had 2.5% variance. The chicken sausage which was taken as control was fallen on the positive side of FC, where plant-based sausage of 30% RJF and 30% BF was fallen on the positive SC side, the remaining two samples 60% RJF and 60% BF were located on the negative side of SC, this two-sample had close correlation than other samples. PCA analysis was done with correlation standardization and all the attributes were having perfect correlations among each other. Attributes like overall acceptability and chewiness are positively correlated on the FC side whereas other attributes like color, taste, and flavor are negatively correlated.

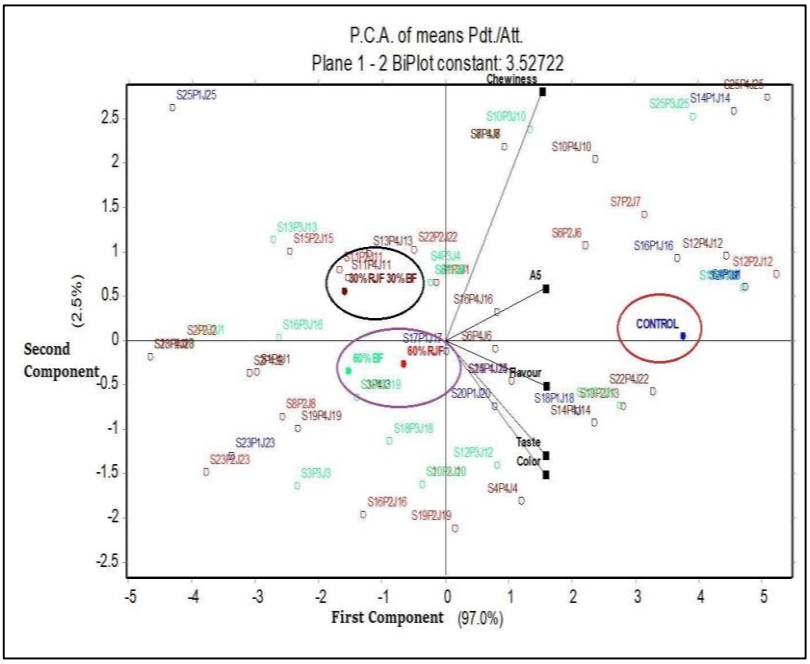

Fig 4: Principal component analysis scores of bi-plot for Products to attributes

In order to understand the relationship or association between the product or judges by attributes are analyzed by PCA was shown in Figures 5,6 and 7; where the attribute color data showed an overall variance of 92% (FC =66.6% and SC =25.4%) and found that all the four samples are located in the different plane; 30%RJF 30%BF present on positive FC side, 60% RJF present on the positive side of SC whereas control were on the negative side of SC and 60% BF were located on the negative side of FC. Attribute flavor has a total data variance of 84.3%, where sample 60% RJF and 30% RJF 30% BF are on the negative side of SC. The flavor of the control sample is located on the positive side of FC, but the sample 60% BF fell on the outlier of the plane. Sample 60% RJF, 60% BF and control sample is having the taste variance of total 84.3%, in which 60% RJF, 60% BF was closely associated on the positive side of FC; control was on the negative side of SC but 30% RJF 30% BF was present on the outlier of the plot. The attribute chewiness is having a total data variance of 86.8%. Further, the sample 60% RJF and 30% RJF 30% BF was associated on the negative side of SC, but the sample 60% BF and control on the positive side of SC and FC respectively. The overall acceptability is having a total data variance of 83.7%, this analysis clearly states that two of the developed plant-based sausage (60% BF and 30% RJF 30% BF) was correlated on the positive side of the FC, where control is on the positive side of the SC and Sample 60% RJF is on the FC negative side. Overall, the PCA results concluded that though the developed sausage has consumer acceptance, they are not having a close association with the control sample.

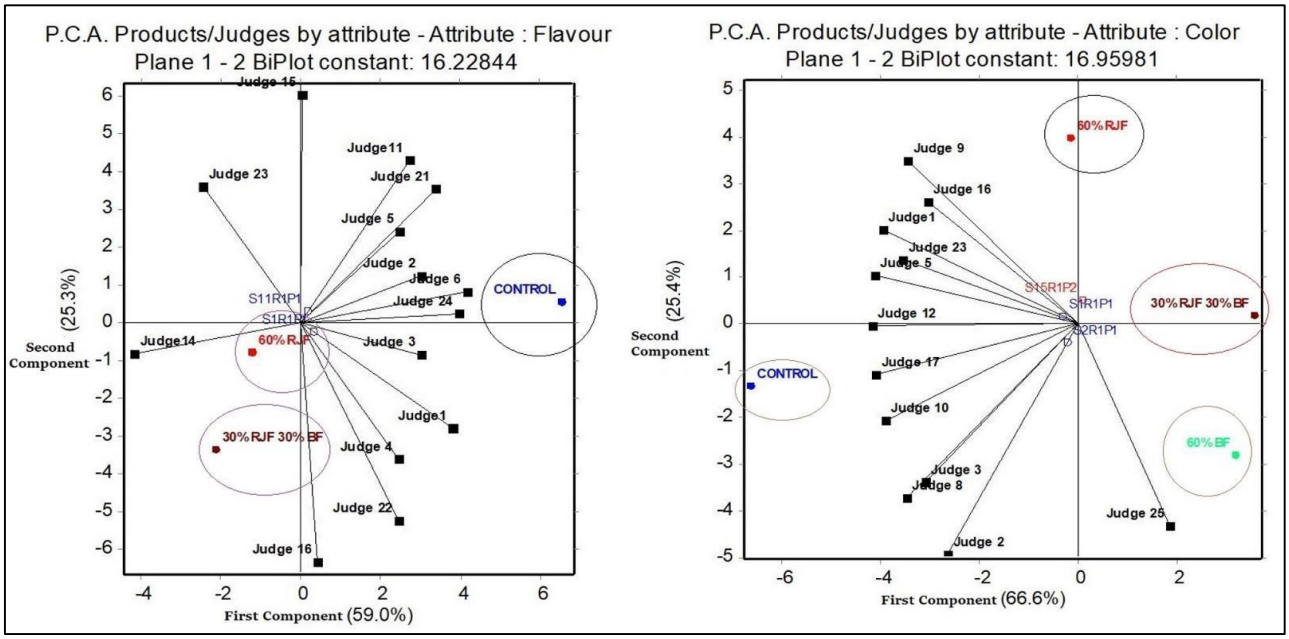

Fig 5: PCA Bi-plot scores for flavor and color attributes

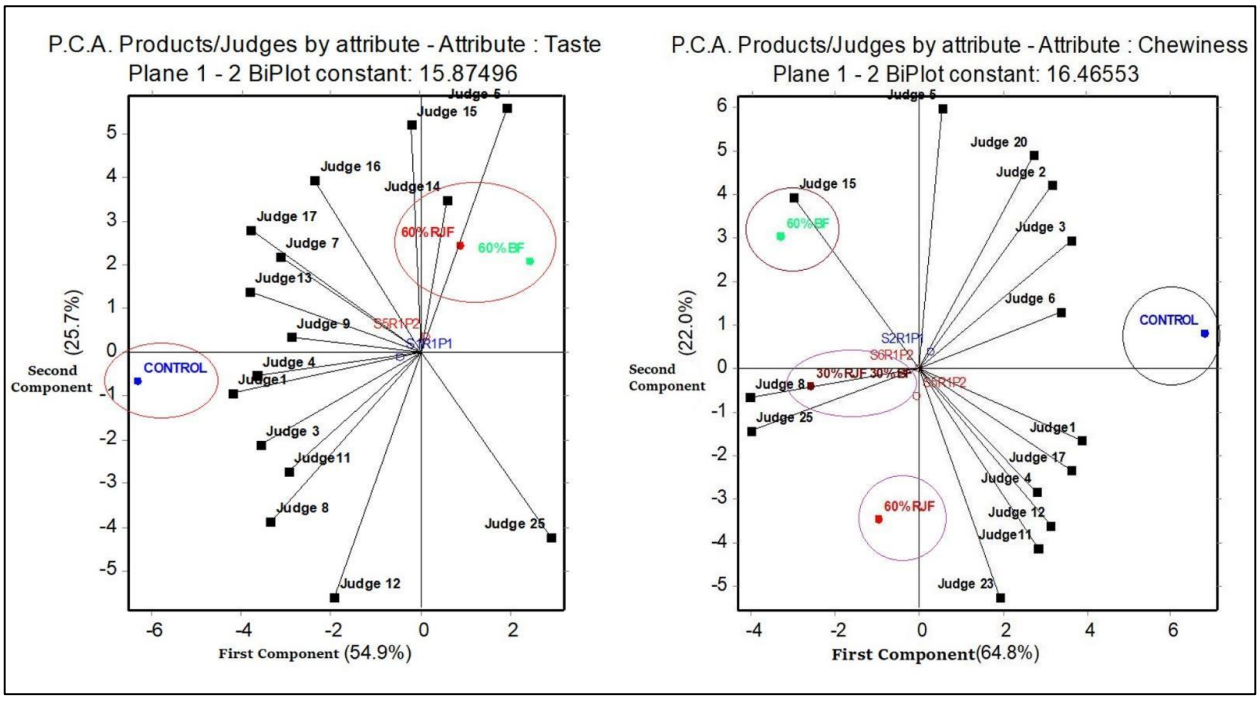

Fig 6: PCA Bi-plot scores for taste and chewiness attributes

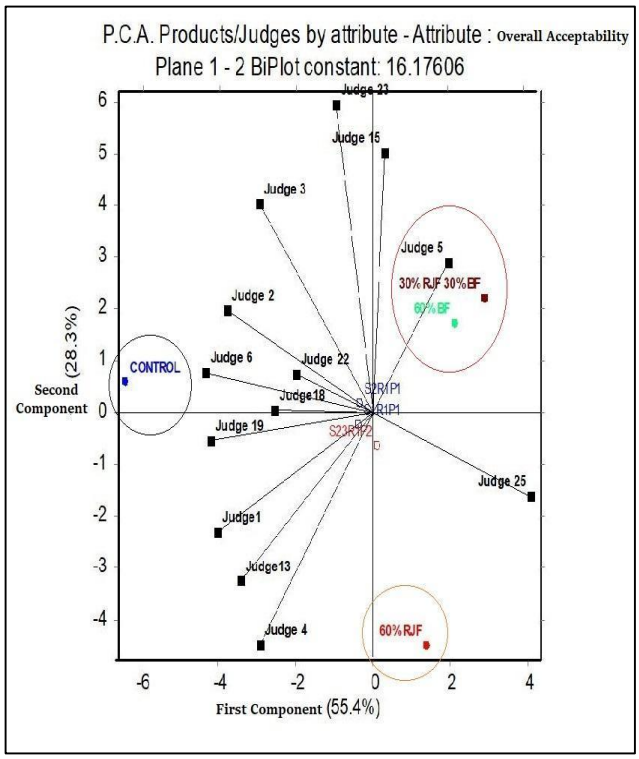

Fig 7: PCA Bi-plot scores for overall acceptability

Conclusion

The main reason for developing the plant-based meat from under-utilized bio-mass like jackfruit and banana floret replaces meat, provides high fiber, protein, and other benefits were these transitions of plant-based meat helps in reducing the carbon footprinting and they are the current trend of sustainable foods globally. From this study, using fizz biosystemes for conducting sensory analysis is supportive because all the processes of data collection and data curation could be systematic, and also it helps in interpreting the collected data through Principal Component Analysis, it is necessary to understand and determine the acceptability of developed plant-based meat samples by a number of variables, including taste, color, flavor, chewiness, and overall acceptability. The results showed that the developed meat sample has sensory acceptance, but it is not having a closer association with the control sample. The advantage of conducting this study is in improving the certain quality aspects or attributes of the food samples during new product development. Involving sensory software helps in managing and accessing the overall components of the analysis.

Conflict of Interest

The authors have declared no conflict of interest

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