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Assessment of Consumer Acceptability of Fortified Elephant Foot Yam (*Amorphophallus paeoniifolius*) Lacto-pickle

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ABSTRACT

Lacto-fermentation makes it possible to store foods without losing nutrients for longer periods of time. We have prepared Lacto-pickle by Lacto-fermentation from tubers of elephant foot yam (EFY) using probiotic *Lactobacillus plantarum* (MTCC-1325). The purpose of this work was to determine the acceptability of consumers of EFY tuber Lacto-pickle on the basis of sensory attributes. Two hundred consumer panelists were chosen mainly from the rural population of India's Odisha State and EFY Lacto-pickle was evaluated in terms of six important sensory characteristics, including aroma, texture, taste, colour or appearance, flavor, after-taste on five-point hedonic scale. In order to understand the sensory attributes (governing the decision process), the responses were modeled through binary logistic regression. EFYis rich in starch and satisfying quantity of crude fibre (2. 66-2. 81 g/100g fresh weight basis) was obtained in fleshy tuber. The crude or dietary fibre of EFY Lacto-pickle along with probiotics has well validated, which improved the palatability and digestive quality of the consumers and also gives the acceptability of this Lacto-pickle. Such model could facilitate the consumption of low-calories or low-fat dietary fibre rich EFY Lacto-pickle and could significantly lower the risk of other complications like hyperglycemia, hyperinsulinemia, glucose intolerance, oxidative stresses.

KEYWORDS

EFY Lacto-pickle; Probiotic; Lacto-fermentation; Fortification; Consumer panel; Sensory attributes

INTRODUCTION

Elephant foot yam (EFY) (*Amorphophallus paeoniifolius* (Dennst.) is a tropical tuber/root used as a local staple food in many countries (Africa, Bangladesh, China, India, Indonesia, Java, Malaysia, Philippines, Sumatra, and south eastern Asian countries) [1]. It is generally consumed either as fresh/unprocessed vegetables or as boiled or baked in the usual human diet of rural and tribal individuals in India and Bangladesh [2]. The tubers (EFY) are rich in starch and sugar as a major energy source. Some EFY varieties contain abundant minerals (i.e., Ca, K, P, and Zn) and vitamins, including riboflavin, thiamine, niacin and vitamin A [2]. Due to presence of dietary fibre the EFY tubers act as functional food. Besides, the presence of healthy low-fat content the EFY

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tubers confers various physiological health benefits or therapeutic potential in individuals with risk factors of degenerative diseases (e.g., diabetes, hyperlipidemia and obesity) [3]. Vegetable pickles have a long history in many countries, including China, Japan, and Korea. Pickles are lactic acid bacteria (LAB) fermented vegetable food is commonly eaten by people due to the good flavor or taste and high nutritional value [4]. In India, EFY Lacto-pickles are well-known and favorite associates that are frequently consumed along with essential/staple foods [5]. EFY Lacto-pickle is the lactic acid (LA) fermented EFY tuber using natural microflora or starter culture and lowering the pH contributes to an increase or growth in sourness and has longer shelf-life. The 'LA spontaneous fermentation' of EFY can occur using lactic bacterial surface microflora i.e., *Lactobacillus spp*., *Leuconostoc spp*., *Pediococcus spp.*, etc. However, the use of 'starter culture' gives consistency and reliability of performance [6]. Several studies reported that consumption of fortified fermented products such as Doenjang (fermented soybean product) [7], Kimchi (fermenting cabbage and other ingredients with probiotic LAB) [8], Gundruk (acidic and picked vegetable) [9], Khalpi (pickled cucumber) [10], Sunki (LA fermented pickle, produced using *Brassica rapa* L). Tomita et al. [11] are acceptable by the consumers (based on sensory attributes) due to various nutritional and health benefits. The pickling of β-carotene and anthocyanin-rich sweet potatoes and their sensory and consumer attributes were evaluated by Sivakumar et al. [12]. The fortified sweet potato pickle found most likely acceptable by the consumers. The sensory perception and end-user acceptance of fermented products is related to several attributes such as texture (i.e., soft or hard), aroma (i.e., fermented or not)), taste (i.e., sweet or not sweet), and color/appearance (i.e., white or off-white) (Bechoff et al., 2018). Review of literature reveals that no sensory studies on EFY Lacto-pickle has been reported. The authors have also standardized the Lacto-pickling of EFY root/tuber (cubes) using Lb. plantarum (MTCC-1325) in submerged fermentation (SmF)in their prior effort [13]. In another study, the biochemical analysis of EFY (*Amorphophallus paeoniifolius*) Lacto-pickle was also articulated with the probiotic Lb. plantarum [14].

The goal of this study is to evaluate the dietary fibre rich, low calorie and healthy low-fat content EFY Lacto-pickle with prospective sensory attributes. The binary logistic regression model is being used to understand the decision process of the consumers in accepting EFY Lacto-pickle and the sensory panel results (with relevance to consumer acceptance) could be procured a new, modified, and healthy EFY food product.

MATERIALS AND METHODS

EFY Roots

The wealthy dietary fibre and low-fat content EFY variety (Cultivar: IGAM-1) having the bio-chemical compositions (g/100g fresh weight basis) *viz*., starch, 23.37-18.58; total sugar, 1.93-1.57; moisture, 65.06-71.79; dietary fibre, 2.66-2.81; crude protein, 1.12-1.63, total ash, 4.78-3.98and crude fat, 0.105-0.141 [14]. Freshly harvested EFY tubers were used within 24 h after harvesting for the preparation of EFY Lacto-pickle [13,15].

2.2 Preparation of Starter Culture

One hundred grams of sweet grapes (source: local market, Rourkela, Odisha) were washed and crushed in a Mixer-cum-Grinder (TTK Prestige Ltd., Bangalore, India) for extraction of the juice. The extracted juice was filtered, boiled and then cooled to room temperature (28 ± 2°C). After cooling, 10 mL(v/v) of starter culture (*Lactobacillus* (*Lb.*) *plantarum* MTCC-1325) was inoculated in grape juice. The entire mixture was kept in an incubator (30°C, 24h) to prepare Lacto-pickle starter culture [13].

Preparation of EFY Lacto-pickle

EFY tubers were collected, washed, peeled and choped into small cubes or blocks (1×1×1 cm^3). The entire EFY cubes were blanched and boiled for 10 to15 min at 70℃. The blanched EFY cubes (140 g) were added to brine solution (8% NaCl, w/v; 300 mL) in uncontaminated glass jar (500 mL). Each plastic jar was inoculated with 10 mL of starter (*Lb. plantarum* MTCC-1325) culture ($1×10^7$CFU/mL) and was tightly covered. The whole EFY brine solutions were incubated (30 ± 2℃) and were left for fermentation (up to 42 days). Finally, the preservative (100µg/g potassium metabisulphite) was added and sealed anaerobically.

Sensory evaluation assay/Modelling consumer acceptability of EFY Lacto-pickle

Consumer panel

In homesteads and/or in isolated farmlands, the EFY tuber is grown and produced mainly by small and tribal farmers. EFY Lacto-pickle was developed to provide additional revenue by adding small-scale value to their farm produce. The EFY Lacto-pickle will allow them to satisfy their nutritional needs at a cheaper price since the pickle is part of their diet. The user panelists were chosen primarily from the rural population of the Odisha State in India. The study was selected two hundred panelists (Male = 135, Female = 65) from the age group of 22-45 years and an average annual income of less than $2500, which is mainly received from agriculture and allied activities. Consumers were asked about the extent or regularity of their consumption of pickles prior to the study and only consumers who regularly consumed pickles were invited to participate in the preferential evaluation. During the district agricultural exhibition/“Kisan Mela” organized by Director of Agriculture and Food production, Odisha and the National Mission of Agricultural and Technology, Odisha jointly during November, 2018, four sensory assessment sessions comprising fifty consumers were conducted. For the analysis, the EFY Lacto-pickle containing 8% (w/v) brine solution was picked. An earlier study by Singh et al. [16] found that in terms of nutrients, minerals, anti-diabetic substances, dietary fibre, starch and above all, taste, the EFY pickle was superior to other variations of the comparable product. This sample was also classified as idealistic by a sensory panel at the laboratory level. A session was held in each process before evaluation in order to familiarize panelists with the product. For the panelists, a careful reading of the questionnaires and the gist of each attribute was suggested to prevent any misinterpretation of the attributes. The clear and odorless glass cups of pyrex (tagged with three-digit haphazard numbers) were used to serve the samples to the individuals (80 g of EFY Lacto-pickle). At the time of serving, the sample temperature was 20℃. The arrangement or plan was made for questionnaires (public-opinion pull) and water for mouth rinsing within each tasting session. The sensory evaluation score was identified as the mean of the panelists’ count. They evaluated EFY Lacto-pickle on a precisely prepared sensory scale consisting of six major sensory attributes (viz. texture, aroma, taste, colour/appearance, flavor, and after-taste). These attributes were carefully chosen after reviewing a broad variety of sensory evaluation studies of fermented food products [17,18]. A five-point hedonic scale was used to test sensory properties of EFY Lacto-pickle (where, maximum score/point, i.e., 5 fitted to "like extremely" and minimum score/point, i.e., 1 fitted for "dislike extremely") and consumers also indicated their acceptability on a nominal scale (1 = acceptable/yes and 0 = not acceptable/no).

Statistical analysis: The “consumer ratings” was visually examined by the arbitrary rating actions of consumers due to consistent evaluation the same number for an attribute

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[19,20]. The independent *t*-test was conducted to measure the mean differences between sensory attributes (i.e., texture, scent, odor, color/appearance, taste, and after-taste) and the random estimate between acceptability categories (i.e. acceptable/not-acceptable). In addition, data was analyzed using binary logistic regression to determine the effect of each sensory attribute on consumers while statistically controlling other attributes [21,22]. A simple mathematical concept of logistic model was preferred because the dependent variable was dichotomous (binary) and awareness of sensory attributes affecting EFY Lacto-pickle's perceptions was too limited to define a complex model [23,24].

In this analysis, the binary response dependent variable (i.e., acceptable or not-acceptable) was selected for consumer acceptability and six sensory attributes were taken as explanatory/independent variables.

During the calculation, logistic regression converted the dependent variable into a logit variable that showed whether or not natural log odds of the response variable occurred [25]. After transformation, the maximum likelihood method (MLM) was used to estimate the probability that a certain event (acceptable/not-acceptable) occurrence occurring. MLM attempts to optimize the log likelihood of observed values of the independent variable. Logistic regression estimated by non-linear procedure was chosen over linear model (estimated by ordinary least squares regression), because it does not involve normally distributed variables and a linear relationship between dependent and independent variables [26]. In addition, this approach has commonly used in market research to model consumer decision processes governing acceptability of products [27]. Binary logistic regression and independent *t*-test and were carried out using software programme SPSS software package (SPSS 13.0; SPSS Inc., Chicago, IL, USA). To confirm its predictive accuracy, the logistic regression model was cross-validated by the statistical software package SAS (Version 9.1) *via* the jackknife process.

Binary Logistic Regression Model

Logistic regression (also called the logistic model/logit model) interprets the relationship between several independent variables (two or more predictors) and a categorical dependent variable (outcome) and calculates the likelihood of an occurrence occurring [28]. Two logistic regression models, binary logistic regression and multinomial logistic regression, are available. Binary logistic regression is usually used when the dependent variable is dichotomous and the independent variables are either continuous or catergorial [28,29]. The binary logistic regression model describing the relationship expresses as a sum of products the expected value of the outcome variable and each product generated by multiplying the independent variable value and its coefficient [23,29]. Moreover, the model is a non-linear regression technique provides for prediction of binary dependent (response) variable which takes a value 1 and 0 (i.e., accepted, y = 1 or not accepted, y = 0) [30]. Logit, the normal logarithm of an odd ratio, is the fundamental mathematical principle underlying logistic regression [12,29]. The odds of an event are the ratio of the probability or likelihood of an event happening to the probability that it will not occur. If the likelihood of occurrence of an event is *p*, the probability of non-occurrence of the event is p (*1-p*). Then the corresponding odds is a value given by

$$Odds\ of\ [Event] = \frac{p}{1-p} \quad ...(1)$$

The mean of the response variable *p* is modelled with logistic regression in terms of the explanatory variable x relating to *p* and x through the equation.

$$p = \alpha + \beta X \quad …(2)$$

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Unfortunately, this is not a good model since extreme values of x will give values of α+βx that does not fall between 0 and 1. Thus, the odds are transformed using the natural logarithm by logistic regression values, i.e. the natural log odds as a linear function of the explanatory variable.

$$logit\ (y) = In\ (odds) = In\left(\frac{p}{1-p}\right) = \alpha + \beta X \quad \ldots(3)$$

Where p is the probability of result concerned and x is the explanatory variable and α and β are the parameters of the logistic regression. In simple form, the logistic regression equation from which the probability of y (dependent variable) was predicted is given by the following equation, (if there is only one predictor or independent variable x_1):

$$P\ (y) = \frac{1}{1+e^{-(\beta 0+\beta 1 X1+\varepsilon i)}} \quad \ldots(4)$$

In which, the P(y) is the probability that binary dependent variable y occurring, e is the base of natural logarithm, x_1 is the predictor (independent) variable, β_0 is the intercept and β_1 is the regression coefficient. Since our study had six predictors (i.e. texture, aroma, taste, colour/ appearance, flavor and after-taste), then the equation becomes,

$$P(y) = \frac{1}{1 + e^{-(\beta 0+\beta tex Xtex+\beta ar Xar+\beta ta Xta+\beta col Xcol+\beta fl Xfl+\beta at Xat+\varepsilon i)}} \ldots(5)$$

where, X_{tex}, X_{ar}, X_{ta}, X_{col}, X_{fl} and X_{at} were sensory characteristics representing texture, aroma, taste, colour/appearance, flavor, and after-taste, whereas β_{tex}, β_{ar}, β_{ta}, β_{col}, β_{fl} and β_{at} were their regression coefficients.

When the equation (2) was converted into natural logarithm of odds (i.e., probability of EFY Lacto-pickle being "accepted" or "not accepted" given the knowledge sensory variables), it provides following logit model:

$$E(y) = \frac{exp(\beta 0+\beta tex Xtex+\beta ar Xar+\beta ta Xta+\beta col Xcol+\beta fl Xfl+\beta at Xat)}{1+exp(\beta 0+\beta tex Xtex+\beta ar Xar+\beta ta Xta+\beta col Xcol+\beta fl Xfl+\beta at Xat)} \ldots(6)$$

Where, E(y) is the log odds of consumers' choice. For a single independent variable (say texture), this suggests that the respondents who liked texture are more likely to accept the EFY Lacto-pickle (while keeping other independent variables constant). Similarly, the model can be interpreted for other sensory attributes too [31].

Evaluation of logistic regression model: There are multiple components involved in the evaluation of the logistic regression model.

Likelihood ratio test: The likelihood ratio test is an overall fit for the analysis of logistic regression and explores a strong link between all independent variables and dependent variables.

The logistic regression model with the k independent variables (given model) is said to provide a better fit to the model data without independent variables (the null model).

$$H_0 : \beta_1=\beta_2 =\ldots =\beta_k = 0 \quad \ldots(7)$$

The difference between the probability or likelihood of the given model and the probability of the null model results a goodness of fit index G, X^2 statistical consistency with k degrees of freedom. The "likelihood ratio test" describes:

$$G = X^2 = -2\ log\frac{likehood\ of\ the\ null\ model}{likelihood\ of\ the\ given\ model} \quad \ldots(8)$$

If the p-value of the overall model fit statistics is smaller than the normative 0.05, then H_0 is rejected with the inference that at least one of the independent variables contributes to the outcome prediction [29,30].

The likelihood-ratio test used to measure the overall fit and contribution to the logistic model of individual predictors. The likelihood ratio test for a given parameter compares the likelihood of the data being obtained when the parameter is zero (L_0) with the likelihood (L_1) of the evaluated data.

$$G = -2\ In\ (L_0/L_1) = -2\ (In\ L_0 - In\ L_1) \quad \ldots(9)$$

Chi-square Goodness of Fit Tests

Chi-square test is based on the residuals. The residuals can be described as $y_i - \hat{y}_i$, where y_i is the dependent variables observed and $\hat{y}_i$ is corresponding model prediction (for the i^{th} subjects) [23,29,]. A standardized residual can be represented as

$$ri = \frac{yi - \hat{y}i}{\sqrt{yi}(1 - yi)} \quad \text{…..(10)}$$

Hosmer-Lemeshow test

The Hosmer-Lemeshow test determines whether the proportions of events comparable to the expected probabilities of the model population. It is carried out by dividing the expected probabilities into deciles, i.e., into 10 classes based on percentile ranks [29,30]. The test statistic is represented as

$$H = \sum_{g=0}^{10} \frac{(Og - Eg)^2}{Og} \quad \text{…(11)}$$

Where, $O_g$andE_g denote the observed and expected events for the *g*th decile group. However, when there is a smaller population size (i.e., n <400), the Hosmer-Leme show test usually not recommended to be used [29].

Wald statistics: Wald statistics are expressed as χ^2 and used in the model to test the significance of individual coefficients. It is calculated as follows:

$$W_{j=\frac{B_j^2}{SE_{B_j^2}}} = [\frac{Cofficient}{SE\ Cofficient}]^2 \quad \text{...(12)}$$

The contribution of individual predictors or the significance of individual coefficients in a given model can be evaluated using Wald statistic [30].

Economics/Cost of production

Considering the actual cost of the products, 10 percent overhead charges, including fermentation charges, 20 percent manufacturing charges (cost of producing grated/chopped/blanched/boiled) and 20 percent profit margin, the development economics (per unit i.e., 140 g) of EFY Lacto-pickle at the laboratory scale was worked out.

RESULTS AND DISCUSSION

As an illustrative example, how sensory attributes influencing consumer perceptions of EFY Lacto-pickle were discussed. The probability of EFY Lacto-pickle increases with the attractive sensory characteristics. However, the relationship between EFY Lacto-pickle and consumer perceptions based on sensory attributes is linear. This pattern is normal since probabilities can be in the range between 0 to 1.

Independent t-Test

The sensory data were initially subjected to variance ratio test to assess whether sensory scores of acceptability categories had similar variance. Insignificant F values for all the attributes suggested that both the acceptance groups had the same variance. For all the sensory attributes, the test provided positive *t*-values, suggesting that consumers who accepted EFY Lacto-pickle gave relatively higher scores than unacceptable group (Table 1). The EFY Lacto-pickle texture is a key factor for consumer acceptance. Texture is the most important criterion for acceptance of the products before taste and smell, according to the local consumers of EFY Lacto-pickle in developing countries [32]. During LA fermentation/processing, most of the textural change of EFY tubers are related to the quality starch and fibre content and their composition (Figure 1). The sensory texture (mean difference 0.49), aroma (mean difference 0.87), and taste scores (mean difference 0.94) differed significantly between the categories of acceptability (P< 0.001). These findings are consistent with the concentrated passion fruit juice [33], natural sweeteners in protein beverages [34] and conferred higher acceptance scores (i.e., attributes texture, flavour, and overall

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impression) (P< 0.05) among the consumers. In a study, the sensory attributes and consumer acceptance of sauces from lactic acid fermented vegetables (carrot, radish, cucumber with pear and mango pulps) were evaluated by Joshi & Sharma [35] and the sensory scores were claimed to be the highest in terms of both taste and flavor. In another study, the sensory properties of consumer acceptance and survival of probiotic bacteria (*Lb. acidophilus*) in the ice cream were investigated by Ferraz et al. [36]. These findings are also consistent with our research that taste and aroma have played a crucial role in the acceptability of EFY Lacto-pickle by consumers.

3.2 Logistic regression Model

Estimating the parameters of the model

The logistic regression parameters were measured by forced entry method (i.e., all variables entered simultaneously) [37]. Six sensory variables i.e., texture, aroma, taste, colour, flavour and after-taste were retained for analysis. One way to evaluate how the regression model fits with the research data is to use the classification table to compare the predictions with the results observed. The respondents were divided into two groups, i.e., acceptable/unacceptable, based on the rule of judgment that if prob (event) ≥ cutoff, the expected event will occur. In the classifications, acute-off value of 0.5 was used. The classification table for “acceptability” in this study demonstrate show well the combination of six sensory variables predicts the acceptability of EFY Lacto-pickle.

Table 2 reveals that 78 consumers were correctly predicted who claimed that that EFY Lacto-pickle was “not acceptable” and 112 consumers who “accepted” EFY Lacto-pickle were also correctly predicted (95 percent of the 200 consumers correctly classified).

Two summary statistics, i.e., log likelihood statistic and goodness-of-fit statistic used from the model to analyze how likely the sample results are to match parameter estimate. The log likelihood statistic is a measure of how much unexplained information is available after fitting the the model. Lower values of - 2 log-likelihood statistic (19.68), significant model chi-square statistic (55.84) and non-significant Hosmer and Leme show goodness-of-fit statistic (3.21) suggest that the model successfully predicts the acceptability of EFY Lacto-pickle (Table 3).

The ‘pseudo’ R^2 (percentage of variance accounted for) estimates like Cox and Snell R^2 (0.75) and NagelkerkeR^2 (0.92) showed that the linear combination of the five independent variables could predict approximately 75 percent (Cox & Snell) and 92 percent (Nagelkerke) of the variance governing the acceptability of EFY Lacto-pickle. Nagelkerke pseudo R^2 is generally preferred because, it achieves a maximum value of one, unlike Cox and Snell R^2 (SPSS, 2000). The logistic coefficients (weights assigned by panelists to specific sensory attributes) were computed in the last stage of the analysis. The significance of these estimated coefficients was determined by Wald statistic, which have a chi-squared distribution and inform us if the β coefficient for the predictor varies significantly from zero [37,38]. The coefficients of colour and textureattributes of EFY Lacto-pickle were significant at 5 percent level, suggesting their effect on acceptability prediction.

The texture, colour and after-taste of Wald values were not significant. Exp (B) is the measure of odds changes arising from a predictor unit change when all other variables are kept constant [38]. If the value is greater than one, then it means that the probability of the outcome happening increase as the predictor increases. Conversely, a value less than one indicates that the likelihood of the outcome decreases as the predictor increases [37]. The results shown in Table 4 show that the aroma, taste and flavor odds ratio were 10.24, 9.248 and 8.246,

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respectively. That is, the chances or odds of EFY Lacto-pickle being liked, accepted and approved by the panelist are 3.8 and 4.7 times higher than those who did not like its aroma and taste. Likewise, the odds of liking the flavour and accepting the EFY Lacto-pickle were 4.4 times higher than those who did not prefer the flavour. Aroma, taste and flavor as influential sensory attributes that determined the acceptability of EFY Lacto-pickle. In various fortified-fermented food samples, several earlier studies have documented the importance of aroma, taste and flavor in acceptability. Panda & Ray [39] was reported that sweet potato lacto-juices enriched with β-carotene was preferred by the sensory panelists due to its yellow color and taste. The wine from jackfruit (*Artocarpus heterophyllus L.*) pulp was investigated fermenting with *Saccharomyces cerevisiae* as starter culture by Panda et al. [40]. The jackfruit pulp added a unique taste and flavour that are strongly liked by the consumers. Although some studied findings are varied, the significance of aroma, taste and flavor of different fortified-fermented foods is well established in consumer acceptability.

Validation of Binary Logistic Regression Model

Validation is a critical step in evaluating the regression model that captured vital relationships in the field of analysis [41]. It was found that the regression model of consumer perceptions towards EFY Lacto-pickle validated with respect to sample size (n = 200), suggesting that the regression model was reliable. The study also reported tests for statistical significance of results. There was minimum possible/minimum correlation between independent variables (two or more predictors) and therefore decreased the variance of coefficients of variables with a reasonably obtained statistical significance of results.

The regression model was cross-validated using the jackknife for its predictive accuracy using jackknife procedure (i.e., resampling for variance and bias estimation). In this technique, the data was split into sub-sets (of equal size) and after dropping one set the probabilities were calculated. The new classification probabilities for EFY Lacto-pickle as accepted (event = 1) and not-accepted (non-event = 0) were obtained. The cross-validation accuracy of this model was calculated to be 90 percent based on classification frequencies, which is very close to the estimated model accuracy of 89 percent. Since both of the accuracies were large and similar, we can infer that this model is reasonably stable and is not overly affected by the model construction data characteristics.

Cost of production of probiotic EFY Lacto-pickle

The cost of production of probiotic EFY (Table 5) based Lacto-pickle showed that the product could be prepared at a reasonable cost with an adequate profit margin. The cost per unit (140 g glass jar) was about Rs. 19.64. The use of fermented EFY for the preparation of pickle will have the effect of making nutritious foods available to consumers at fair prices. To date, efforts to develop commercially useful probiotic fermented EFY Lacto-pickle containing the viable LAB (*Lb. plantarum*) have not been developed and/or successfully marketed.

CONCLUSION

The logistic regression one of the most important statistical technique used, when outcome variable is dichotomous. Consumer evaluation (of regression model) identifying the consumer decision process on EFY Lacto-pickle based on associations of sensory attributes. Aroma, taste and flavor varied significantly and positively affected consumer acceptability among the six sensory attributes. The independent *t*-test confirmed that there was a significant difference between acceptable groups.

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However, the interpreting results of regression model and the significant outcome of regression coefficient expressed the statistical associations, but not necessarily casual effects of probiotic fermented EFY Lacto-pickle accepted by the consumers. Nevertheless, the products descriptive sensory attributes/profile (EFY Lacto-pickle) and also consumers acceptance are important for the sale/marketing of fermented pickle that can be consumed and/or enjoyed. In addition, this study found that the use of fermented EFY Lacto-pickle would lead to for the supply of nutritious/healthy foods to consumers at reasonable price.

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CONFLICT OF INTEREST

Authors have no conflict of interest for publishing the research.

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