Formulation and evaluation of sweet corn milk (*Zea Mays*) based mayonnaise

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Abstract

Vegan foods have shown an increasing trend in food consumption patterns, where the demand for vegan products is affected by physiological, socioeconomic, cultural, ethnic, and several other factors. The vegan market is predominantly occupied by soy-based products, whereas the remaining is constituted by almond, walnut, and other plant sources, which are comparatively high in cost. Exploring new sources for vegan products which are economical and commercializing could attract consumer's attention and could have a good market share. Sweet corn is consumed across the world and is known for its unique taste and flavor. One of the major concerns with sweet corn is the very short optimum maturity period, before and after which it loses its characteristics. Various studies have formulated yogurt milk, native Indian products like dahi, shrikhand, etc., with corn milk in its pure and blended forms. An online survey was carried out to understand Consumers preference for vegan foods. The preliminary survey conducted revealed that respondents were open to trying out vegan mayonnaise when they had to choose among vegan products. Therefore, in this study, mayonnaise was formulated using sweet corn milk. Nutrient and sensory analyses were conducted for the mayonnaise samples. Organoleptic properties were evaluated using 9- point hedonic rating scale, duo-trio, and triangle tests. One-way ANOVA for the hedonic rating test revealed that there were no significant differences between control (eggless mayonnaises) and test samples (sweet corn milk mayonnaises). Nutrient profiling of sample V1 (SCMM 1:1) had the following result :417.6Kcal, 3.37g carbohydrates, 5.63g protein, and 42.40g fat per 100g.

Keywords: sweet corn mayonnaise, Sweet corn milk, vegan food, vegan mayonnaise

Introduction

Dairy alternatives or substitutes have become a popular consumption trend notifying the shift in the nutritional, socio-economical, and physiological status of the population. Consumption of dairy alternatives has taken a great spike with increasing veganism. Plant-based milk alternatives have the highest market share among vegan products. Milk alternatives are the ones where liquid milk analogs are extracted from various plant sources (cereals, pseudo cereals, legumes, and oils seeds), by soaking and grinding followed by filtration and further processed for homogenization for maintaining the particle size (5 – 20 µm) similar to dairy-based milk to imitate its appearance and consistency (Sethi *et al*,2016) [10].

Milk alternatives have seen an increase in demand due to the increasing prevalence of lactose intolerance and cow milk protein allergy. Lactose intolerance can lead to discomforts like bloating and flatulence. Whereas, Cow milk protein allergy (CMPA) can lead to allergic reactions, which can sometimes lead to anaphylactic shocks (da Silva *et al*, 2019) [2].

Some of the common vegan products that are available in the market include milk, yogurts, mayonnaise, fermented cheese etc., where dairy alternative milk is produced in a large scale and are made available easily in the market. Soy dominates the vegan food range, due to the ease of getting formulated into different products such as soy milk (whole), combined soy milk, flavored soy milk, yogurts, mayonnaise, tofu etc., Even though, other

plant-based milk such from almond, cashew, coconut are picking up their sales, but the market is still dominated by soy. Researchers are highly interested to find various new sources for vegan product formulation and standardization.

Sweet corn milk is an extract that is obtained by grinding and filtering of kernels. It can be considered as a potential plant-based milk alternative and is being studied for its properties and quality. Several studies were done with sweet corn for the production of blended vegan milk, yogurt, native Indian products like shrikhand (Masih *et al*, 2020) [7], gulab jamun (Patil *et al*, 2017) [9] and dahi (Padghan *et al*, 2015) [l]. Utilizing sweet corn for formulating novel products like mayonnaise, white sauce base will increase the crop utility and reduces agricultural waste. Mayonnaise is a popular dip, which is consumed with or without flavorings. It is an emulsion that is formed with the addition of oil and liquids (where an egg is used and in case of eggless mayonnaise, milk or reconstituted milk solids are used). It usually contains vinegar, spices, salt and sugar, and other flavorings, emulsifiers, and antioxidants. Emulsion stability is majorly contributed by emulsifiers like Xanthan gum in eggless mayonnaises, whereas in egg-based mayonnaise, yolk and stabilizer contribute equally. (Singla *et al*, 2012)

Dips are commonly consumed with all types of foods and are preferred for their flavor and taste. Similarly, sweet corn is preferred for its flavor and sweetness. Being a novel source to the

vegan range, exploring its characteristics will help in understanding the processing parameters, formulation, and sensory characteristics. Since it's an abundantly cultivated crop in south India, processing and value addition will help in increasing its shelf life and improves its market value. Therefore, formulating mayonnaise, an emulsion that is commonly prepared from egg or milk, when substituted with sweet corn milk can be the better option for making the maximum use of the sweet corn production.

This study aimed to understand the consumers' attitude and preference towards vegan foods, consumer preferences towards dips, and to formulate and evaluate sweet corn milk-based mayonnaise.

Methodology
Survey on Consumer Attitude and Preferences towards Vegan Foods
A preliminary survey was conducted with a self-administered, structured questionnaire to understand and evaluate the consumer attitude and preferences towards vegan foods, estimate the taste and flavor preferences of the respondents. The first half of the questionnaire was designed to collect the basic information about respondents, whereas the latter part was designed to collect information about diet pattern, factors affecting the food choices, reasons which would make them choose vegan foods etc., The questionnaire was circulated through emails in online mode, using a convenience sampling method.

Raw Material Procurement
Raw materials which include sweet corn, oil, spices, and vinegar were purchased from a local market in Chennai. Emulsifier (Xanthan Gum) was procured from Sattvic Foods, Chimbel, Goa, and Seasoning (Peri-peri) were procured from Keya Foods, Thuravoor, Kerala.

Preparation of Mayonnaise
After carefully separating the kernels from the cob, the sweet corn was ground into a fine paste with a blender and filtered to obtain the corn extract. The extract obtained was diluted with water in the ratio of 1:1 and 1:1.5 (corn extract: water). Both the variations were used for formulating mayonnaise. Mayonnaise was prepared by blending sweet corn milk, oil, emulsifier, vinegar, salt, sugar, spices, and flavoring at high speed in a blender.

Table 1: Composition of Control and Sweet corn milk Mayonnaise

Ingredients	C2	V1	V2
Cow milk	47.5ml	-	-
Sweet corn milk	-	47.5ml	47.5ml
Oil	47.5ml	47.5ml	47.5ml
Salt	1g	1g	1g
Sugar	1g	1g	1g
Pepper	0.5g	0.5g	0.5g
Vinegar	1ml	1ml	1ml
Xanthan gum	1g	1g	1g
Flavour (Peri peri)	1.5g	1.5g	1.5g

Fig 1: (Left to right) Commercial eggless mayonnaise - C1, Homemade eggless mayonnaise - C2, Sweet corn mayonnaise 1:1 - V1, Sweet corn mayonnaise 1:1.5 - V2.

Sensory Evaluation
Hedonic rating test, triangle test, and duo -trio test was conducted for Controls (Eggless commercial mayonnaise – C1, Eggless homemade mayonnaise – C2) and Samples (Sweet corn milk mayonnaise / SCMM 1:1 – V1 and Sweet corn milk mayonnaise/ SCMM 1:1.5 – V2).

Hedonic rating test involved grading of five attributes (Appearance, taste, flavor, texture, and overall acceptability) with a 9-point hedonic scale.

Duo-trio tests and triangle tests were conducted with different combinations of controls and variations and interchanged accordingly for each panelist to minimize errors. The above tests were conducted with 7 semi-trained panelists. Significant differences in the samples have been established by counting the number of correct responses and comparing with the tabulated minimum correct responses by Lawless & Heymann, 2010. The table contained tabulated values which were calculated by applying a one-tailed test, where $p=1/3$ for triangle test and $p=1/2$ for the duo-trio test were applied. Significant differences in samples were established when calculated values of correct responses were greater than tabulated values.

Nutrient Analysis
The following nutrients - carbohydrates, protein, fat, energy, dietary fibre, ash, magnesium and calcium are estimated by AOAC and IS methods. The total soluble solids (TSS) were also determined by standard method.

Table 2: Coding for mayonnaises used in the study

Samples	Codes
Commercial eggless mayonnaise	C1
Homemade eggless mayonnaise	C2
Sweet corn milk mayonnaise (1:1) / SCMM 1:1	V1
Sweet corn milk mayonnaise (1:1.5) / SCMM 1:1.5	V2

Table 3: Sample combinations for Duo-trio

Combination	Samples
Triad 1	R (C2), V1, C2
Triad 2	R (C1), V1, C1
Triad 3	R (C2), V2, C2
Triad 4	R (C1), V2, C1
Triad 5	R (C1), V1, C2
Triad 6	R (C1), V2, C2

Table 4: Sample combinations for Triangle test

Combinations	Samples
Triad 1	C2, V1, C2
Triad 2	C1, V1, C2
Triad 3	C1, V2, C1
Triad 4	C2, V2, C2

Statistical Analysis

One-way ANOVA was applied using MS – Excel 2013, for Hedonic rating test under sensory evaluation to understand if there were any significant differences in the samples. Survey results were reported with descriptive statistics.

Results and Discussion

Survey on consumer attitudes and preferences towards vegan foods

Demographic Background of respondents

Around 282 respondents (n=282) took part in an online survey that was conducted to understand the consumer attitudes and preferences towards vegan foods. Respondents between age of 18 – 65 were considered for this survey, where around 58.16% (i.e., 164 respondents) were between the age of 18 – 22 years, forming the major part of this survey. Of the total respondents 53.90% were male and 46.10% were female respondents. Students constituted to around 53.19% (i.e., 150 respondents), job or employed respondents in either private or government sector formed up to 25.53% (i.e., 72 respondents) and entrepreneurs comprised of 8.51% of the respondents. Around 40.43% of the respondents had more than INR 50,000 as their family income, whereas 7.80% had income less than INR 10,000.

Diet Pattern

The Diet pattern of the respondents revealed that almost half of the respondents (55.96%) were non-vegetarians. 18.77% of respondent were Lacto-vegetarians (diet contains animal milk but does not include eggs and flesh), 14.80% were Lacto-ovo vegetarian (diet includes animal milk and eggs, but does not include flesh), 8.66% were vegetarians (diet does not include eggs, meat or milk from animals).
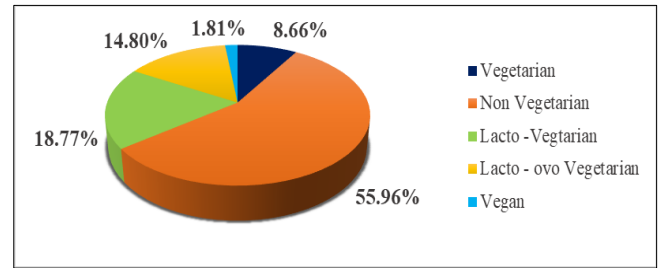

Fig 2: Diet pattern of the respondents

Dairy Preferences

Of the two options, animal-based dairy, and plant-based dairy, the majority of the respondents preferred animal-based dairy (60.28%) over plant-based (39.72%).
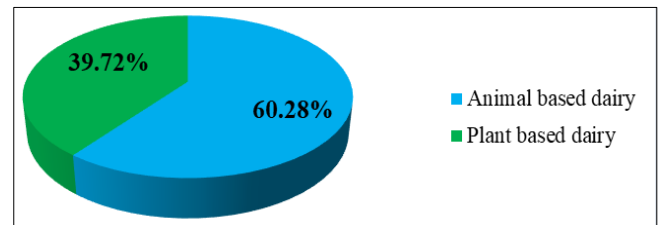

Fig 3: Dairy preferences of respondents

Reasons to Choose Vegan Foods

Several reasons affect the diet pattern. Some of the reasons which include health, economic and other ethnic beliefs were given to respondents to understand why they would possibly shift to a vegan diet pattern. Around 24.88% did not prefer to have plant-based dairy or diet. Major reasons which would influence consumers were 'to have a low-calorie intake' (18.47%), "consider plant-based diet as more nutritious than animal-based dairy" (18.23%), and 'to have a low or no cholesterol intake' (17.49%). Other reasons constituted up to 20.94%, where respondents shifting to a plant-based diet to avoid cruelty towards animals comprised up to 10.84%, cultural/ ethnic beliefs impacted the choice of 5.67% of the respondents. Lactose intolerance accounted for 4.43%.
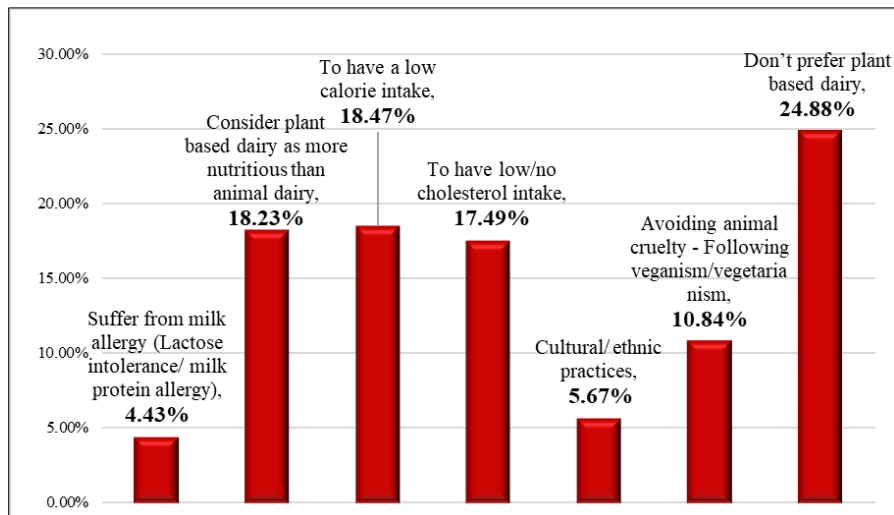

Fig 4: Reasons to choose vegan products

Factors Affecting Vegan Choices

Factors that affect consumers' choice for vegan products were evaluated by the respondents. The factors that were chosen were better nutrition (32.43%), taste (23.96%), availability (17.48%), just as a mere addition to the variety of foods consumed (13.15%), and cost (12.97%).
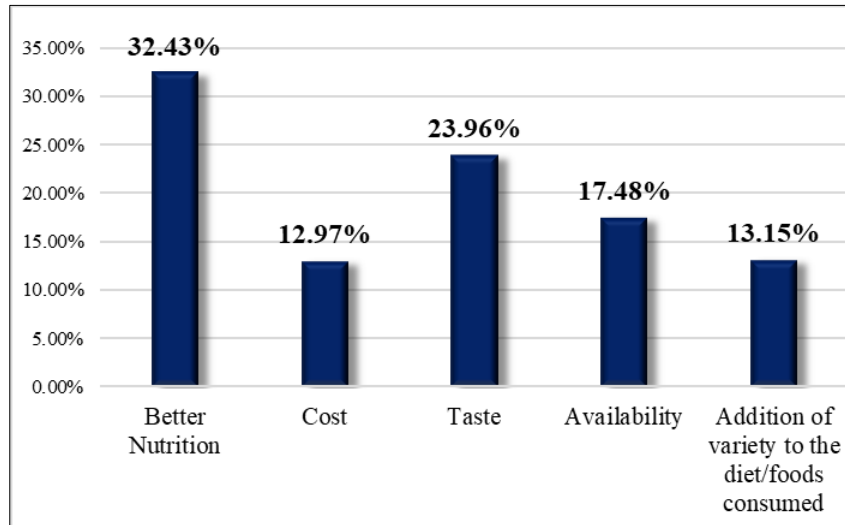

Fig 5: Factors affecting Consumers choice for vegan products

Frequency of DIP Consumption

The frequency graph showed that most of the dips was consumed once a week. Mayonnaise showed its highest frequency once in a week (30.14%), and 25.18% of the respondents had it rarely (a gap between consumptions usually exceeds 30 days).
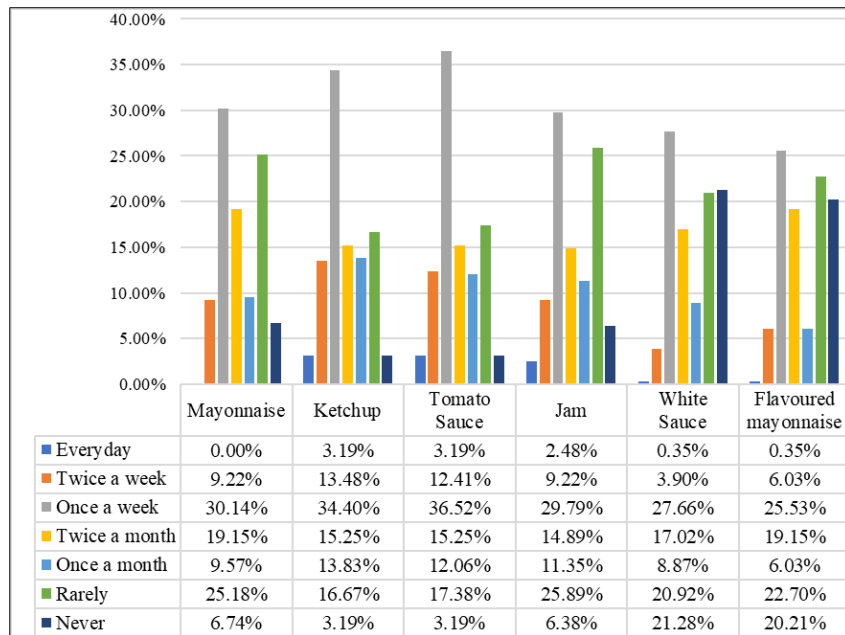

	Mayonnaise	Ketchup	Tomato Sauce	Jam	White Sauce	Flavoured mayonnaise
Everyday	0.00%	3.19%	3.19%	2.48%	0.35%	0.35%
Twice a week	9.22%	13.48%	12.41%	9.22%	3.90%	6.03%
Once a week	30.14%	34.40%	36.52%	29.79%	27.66%	25.53%
Twice a month	19.15%	15.25%	15.25%	14.89%	17.02%	19.15%
Once a month	9.57%	13.83%	12.06%	11.35%	8.87%	6.03%
Rarely	25.18%	16.67%	17.38%	25.89%	20.92%	22.70%
Never	6.74%	3.19%	3.19%	6.38%	21.28%	20.21%

Fig 6: Consumption trend of dips

Preference in Vegan Product and Rating for Vegan DIPS

Around 30.85% respondents were willing to try out mayonnaise in vegan range. Other preferences were for vegan milk (25.89%), vegan butter (20.57%), vegan yogurt (16.31%) and vegan white sauce (6.38%). The respondents were asked to rate the vegan dips on the scale of 1-5 ranging from disliked most – liked most. 62.77% of the respondents expressed a positive liking for the product by choosing between 4 and 5 (liked and liked most)

Taste and Flavour Preferences

For understanding taste preferences, basic tastes in which commercial dips are already available like spicy, sweet, sour, and bland were given, out of which 67.73% preferred spice nature, 21.63% preferred sweetness, 6.03% opted for sourness, and 4.61% chose bland taste in the dips. Common flavors in dips like peri-peri, tandoori, sriracha, mint, ranch, onion, and garlic were given to know the preference of consumers. Tandoori (21.85%),

peri-peri (21.54%), and garlic (20.15%) were the top 3 preferred flavors.

Sensory Evaluation

Hedonic rating test

Table 5: Hedonic rating test scores

Sample	Appearance	Texture	Flavour	Taste	Overall acceptability
C1	8.14 ± 0.63	7.85 ± 0.63	8.57 ± 0.72	8.14 ± 0.63	8.14 ± 0.63
C2	8.28 ± 1.03	7.71 ± 0.69	8 ± 1.06	7.71 ± 1.66	8.28 ± 1.03
V1	8 ± 0.75	7.57 ± 0.90	7.71 ± 1.03	7.57 ± 1.29	7.85 ± 0.34
V2	8 ± 0.75	7.42 ± 0.90	7.71 ± 0.69	7.57 ± 0.72	7.85 ± 0.83

Values are mean ± standard deviation of 7 panelists

V1 and V2 had a darker appearance when compared to controls (C1 and C2), this could be attributed to the yellow color of sweet corn milk. Overall acceptability and flavor scores of sweet corn milk mayonnaises were lower than that of the eggless mayonnaise.

One-way ANOVA for all the sensory attributes revealed that there were no significant differences between the samples. It can be inferred that test samples were as acceptable as control samples.

Duo-Trio Test
In triads 1,2,3,5 and 6, the number of correct identifications or calculated values is less than the required minimum number of correct responses needed to establish significant differences among the samples. Therefore, it can be assumed that panelists found V1 and V2 more similar to controls. Only triad 4 had the required number of correct identifications, with which it is concluded that V2 and C1 varied significantly.
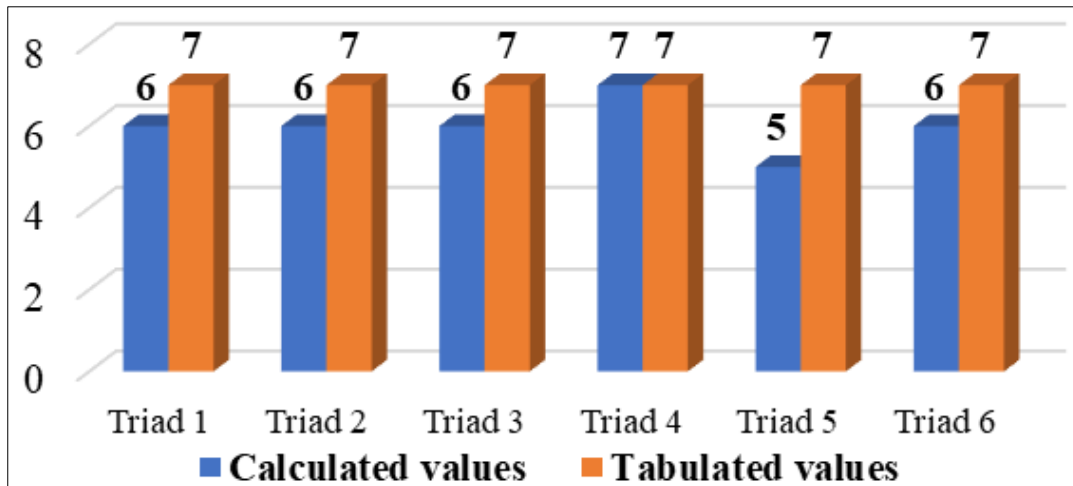

Fig 7: Comparison between tabulated and corrected values for Duo-trio test

Triangle Test
In all the triads, the panelists have correctly identified the odd sample from the given triad combinations. With the results of the triangle test, it was concluded that in all the triads the samples were significantly different from controls.
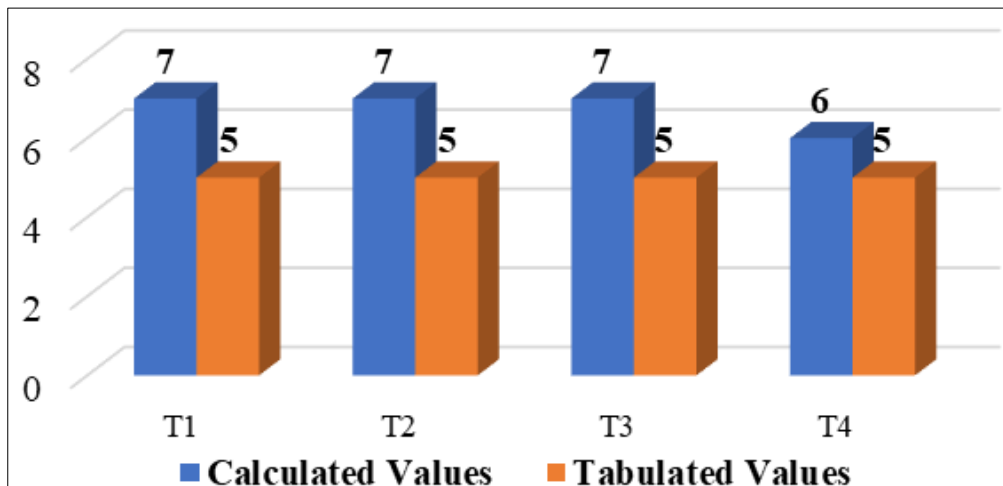

Fig 8: Comparison between tabulated and corrected values for Triangle test

Nutrient Analysis

Nutrient profile of Sweet corn milk mayonnaise (V1) is presented in Table 6.

Table 6: Nutrient composition of V1 (Sweet corn milk mayonnaise 1:1)

Parameter	Value
Energy (Kcal/100g)	417.60
Carbohydrate (g/100g)	3.37
Protein (g/100g)	5.63
Fat (g/100g)	42.40
Dietary fibre (mg/100g)	<1mg
TSS	83.0
Calcium (mg/100g)	< 1mg
Magnesium (mg100g)	<1mg

The nutritive value of sweet corn milk mayonnaise (V1) 1:1 dilution when compared with commercial eggless mayonnaise, contained lesser calories, fat, and carbohydrates content. But the protein content of the sweet corn milk mayonnaise is much greater than the commercial eggless sample.

Conclusion

A preliminary survey that was conducted revealed that respondents preferred to try out mayonnaise among the vegan range. Mayonnaise was formulated with sweet corn milk which was extracted with two different dilutions (V1 and V2). Responses revealed that consumers considered vegan alternatives as low-calorie foods, and as more nutritious and has low cholesterol content. Consumers would like to shift to vegan foods for better nutrition and taste. Hedonic rating test showed that there were no significant differences in basic sensory attributes like (Appearance, texture, taste, flavor and, overall acceptability) between the controls and samples. Duo trio test revealed that samples were more similar to controls which were given as references. The Triangle test revealed that some differences could be identified by the panelists. Sweet corn milk mayonnaise can be used for providing a better nutritive alternative along with better taste and flavor. It can be used to improve the optimum and timely utilization of the crop

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