Asian J Biol Life Sci., 2025; 14(1):119-126.
https://ajbls.com

Nutritional Comparison of Vegan Yogurts Prepared Using Non-Dairy Lactic Acid Bacteria

Ponnamma Madaiah[1,2], Poojitha Kishore[1], Rakshitha Krishnarajapete Ravi[1], Swathi Deepak Nayak[1], Soumya Kallekkattil[1,*]

[1]Department of Zoology, Jyoti Nivas College (Autonomous), Bengaluru, Karnataka, INDIA.
[2]Department of Biotechnology, Manipal School of Life Sciences, Manipal, Karnataka, INDIA.

ABSTRACT

Aim: Yogurt is a probiotic-rich fermented dairy product made by lactic acid fermentation using various bacteria. This study explored using chili stalks, a waste product from the chili industry, as a natural starter for fermenting both dairy and plant-based milks like soy, peanut, chickpea, and oat milk into yogurt. **Materials and Methods:** A plant-based milk was fermented using non-dairy lactic acid bacteria derived from *Capsicum* spp., namely red and green chillies. These samples of milk were inoculated with red and green chilli stalks. In these yogurt samples, various nutritional parameters were analysed, including protein, fat, ascorbic acid, and lactic acid content. **Results:** It was recorded that Red chili stalk inoculated Soy Yogurt (RSY) had the highest protein content (9±0.01)/100 g; fat content was the highest in peanut yogurt (25.51 g/100 g) and the Red chilli stalk inoculated Chickpea Yogurt (RCY) recorded the highest content of lactic acid (0.31%). Compared to green chilli stalks, red chilli stalks were generally higher in ascorbic acid. It can be concluded that the soya yogurt inoculated with red chili stalk provides superior nutritional benefits compared to peanut, chickpea, and oat yogurt.

Keywords: Chickpea, Chilli stalks, Nutrition, and Yogurt.

Correspondence:
Dr. Soumya Kallekkattil
Assistant Professor, Department of Zoology, Jyoti Nivas College Autonomous, Bengaluru-560095, Karnataka, INDIA.
Email: soumya.ramesh436@gmail.com
ORCID: 0000-0001-9952-3132

Received: 24-11-2024;
Revised: 18-01-2025;
Accepted: 05-03-2025.

INTRODUCTION

Probiotics can be found in yogurt, a fermented dairy product produced by fermenting milk with lactic acid.[1] *Lactobacillus*, *Lactococcus*, *Enterococcus*, *Streptococcus*, *Pediococcus*, *Leuconostoc*, and *Weissella* are among the lactic acid bacteria traditionally used to ferment milk. Bacterial fermentation reduces the pH of milk by converting milk sugar lactose into lactic acid.[2] Traditionally, fermented foods such as yogurt are prepared using microorganisms based on raw materials and local practices where, curdling of milk may be induced by adding several different curdling agents or by adding a small amount of preformed curd, with subsequent incubation at a warm temperature.[3] However, this method reduces the nutritional value of curd over time and also its physiochemical characteristics decreases due to the slowing down of the original bacterial activity. Therefore, as an alternative, this study used chili stalks. As chilli stalks contain a variety of lactobacilli, we used them since *Capsicum* fruits like chillies have been shown to contain a great deal of lactobacilli. Milk's lactose fermentation starts with these natural bacteria.[4] Presence of capsaicin (8-methyl-N-vanillyl-6-nonenamide) in chilli increases the metabolic rate of the lactobacilli. Additionally, capsaicin plays a crucial role in metabolic disorders, such as weight loss, blood pressure lowering, and insulin reducing.[5,6] A total of 1.7 million tonnes of chillies are produced in India each year. The stalks have no value as fertilizer or feed, and incineration or burning is not practical due to the lingering pungency. Industries produce thousands of tons of stalks and calyces as waste.[7] These stalks can, however, be turned into high-value products by curding milk with them. Additionally, it provides a healthier starter culture for yogurt making, which is more economical than purchasing store-bought yogurt.[1]

In recent times, there has been an increasing demand from consumers for non-dairy milk such as plant milk due to its enormous advantages over dairy milk. Dairy milk is not easily absorbed and digested by all, as it contains high saturated fat, sugars, hormones, and antibiotics.[8-10] The low-calorie, lactose-free, and cholesterol-free properties of plant milk have made it a great alternative for people who cannot digest dairy products. People have recently been using plant milks such as soy, coconut, almond, rice, peanut, chickpea, and oat milk due to their high functional properties. This study used all these milks except coconut, almond and rice milks as alternatives for dairy milk for fermenting into yogurt using chilli stalks.

DOI: 10.5530/ajbls.20251739

People having bovine allergy to milk and lactose often use milk from soy as a dairy milk replacement due to its health benefits.[11] Fermenting soya milk into yogurt is extremely advantageous as it not only reduces the beany flavour but also enhances its nutritional value, flavours, and textures. Peanut milk is nutritionally significant as it contains almost 20 amino acids, along with essential fatty acids which has a vital role in cholesterol level as the amount of Low-Density Lipoprotein consumed is comparatively less than dairy milk and plays an important role in fighting against malnutrition.[12] As a good replacement for soymilk, chickpea milk is becoming more popular due to its non-allergenic nature and low lipid content[13,14] coupled with its ability to control persistent diarrhoea.[15] Since oats contain dietary fibres, proteins, and lipids, they have gained scientific and public interest due to their potential for producing plant-based milk.[16,17] Oat milk is rich in vitamins like A, B1,D, E, along with minerals such as calcium, iron, sodium, potassium and magnesium[18] and it also does not contain any of the top eight food allergens.[19]

Plant milk offers both environmental and nutritional benefits compared to dairy milk. To address this issue, the present study used chilli stalks as potential starter for fermenting dairy milk alternatives, such as soymilk, peanut milk, chickpea milk, and oat milk, into yogurt. The stalks of chilli are a source of non-dairy LAB and this is determined by calculating fermentation indicators such as pH and percentage of lactic acid in yogurt. The study also focuses on analysing its nutritional value by carrying out certain standard tests for protein, carbohydrates, fat, and ascorbic acid in different vegan yogurts.

MATERIALS AND METHODS

Sample preparation

Extraction of soymilk

About 50 g of soybeans were cleaned and soaked for 14-16 hr at room temperature (28ºC) with distilled water. The water was changed at regular intervals of 3 hr to prevent fermentation. With 400 mL of water and soybeans soaked and blended for two min, a milky-looking filtrate, known as soybean milk, was obtained. We sterilized soy milk at 121ºC for 20 min at 15 pounds per square inch.[22]

Extraction of peanut milk

We cleaned and soaked 50 g of groundnut samples for 18 hr at 28ºC in water and changed the water at regular intervals of 3 hr to avoid fermentation. The groundnut was soaked, drained and blanched in hot water for 5 min. To make fresh groundnut milk, it was blended and sieved with 375 mL of potable water. The obtained groundnut milk was heated to 90ºC for 5 min.[1]

Extraction of chickpea milk

After washing and soaking the chickpeas for 12 hr in distilled water, they were mashed. In 400 mL of water, 50 g of swollen chickpeas were ground (ratio 1:8 w/v). A double-layer gauze filter was used for separating insoluble residues from the slurry after it was cooked at 85ºC for 15 min.[23]

Extraction of oat milk

The amount of oat flakes needed to make 500 mL of oat milk was about 50 g. A cloth was thrown over the oat flakes overnight (12 hr) and they were soaked in water for 12 hr. Oat milk was prepared by thoroughly grinding the ingredients in a mixer grinder (about 2 min). Using a fine sieve or muslin cloth, the milk was strained into a bowl. The obtained oat milk was heated to 90ºC for 3 min.

Inoculation and yogurt preparation

The prepared soymilk, groundnut milk, chickpea milk, and oat milk were cooled down to 42ºC, 60ºC, 38ºC, and 45ºC respectively. These four samples of milk were equally divided into three beakers. One beaker labelled as 'A' were inoculated with 7-8 red chilli stalks, and another one labelled as 'B' were inoculated with 7-8 green chilli stalks. As a reference, the third beaker was labeled as 'C' and inoculated with yogurt that contained active live lactic acid bacteria. The preparation of the yogurt was conducted in alignment with the methodology delineated by.[20]

Sensory evaluation

Our sensory attributes included color, aroma, taste, texture, mouth feel, and Overall Acceptability (OAA). Ten consumers rated the samples using a nine-point hedonic scale.[21] Four samples were presented at a time in cups containing approximately 100 g and sensory scores were recorded.

Chemical analysis

Determination of pH

The pH values of yogurt samples were measured after incubation period using a standardised electrode of the digital pH meter at 35ºC. After the 8 hr incubation period at 35ºC.

Titratable acidity

Using phenolphthalein as an indicator, 10 mL of sample was titrated against 0.1N NaOH. Titratable acidity was calculated as percent lactic acid based on the title value.

$$\text{Total acidity \%} = \frac{ml \times N \times 90 \times 100}{V \times 1000}$$

Where, mL=volume of 0.1N NaOH run down,

N=normality of NaOH,

V=volume of samples used.

Table 1: Mean sensory scores of different plant-based vegan yogurt samples with various inoculants.

Attributes	Colour	Appearance	Flavour	Mouthfeel	Overall acceptability
T1	8.5±0.52 [a]	9±0 [a]	7.8±0.78 [a]	8.5±0.52 [a]	8.8±0.42 [a]
T2	8.7±0.48 [a]	9±0 [a]	7.2±0.78 [ab]	8.0±0.66 [a]	8.6±0.51 [a]
T3	7.1±0.73 [b]	7.1± 1.1 [bc]	6.8±0.78 [abc]	5.7±0.82 [d]	8.5±0.52 [ab]
T4	7.3± 0.82 [b]	7.3 ±1.05 [bc]	6.2±0.78 [bcd]	5.5±0.52 [d]	8.2±0.63 [abc]
T5	7.7±0.67 [ab]	6.3±0.67 [c]	5.9±0.87 [cd]	6.5±0.84 [cd]	7.1±0.96 [bcd]
T6	7.7±0.94 [ab]	6.5±0.81 [c]	5.4±0.51 [d]	6.2±0.91 [cd]	6.6±0.96 [cd]
T7	7.2±0.91 [b]	7.6±0.84 [b]	7.7±1.05 [a]	7.7±0.94 [ab]	7.3±0.94 [d]
T8	7.1±0.73 [b]	7.9±0.73 [b]	7.4±0.51 [a]	6.8±0.74 [bc]	7.0±1.05 [d]

Values represents in Mean±SD. Means in columns followed by different alphabets are significantly different (Tukey's HSD test, $p < 0.05$, ANOVA).“T1”-soya yogurt inoculated with red chilli stalks.“T2”-soya yogurt inoculated with green chilli stalks.“T3”-peanut yogurt inoculated with red chilli stalks.“T4”-peanut yogurt inoculated with green chilli stalks.“T5”-chickpea yogurt inoculated with red chilli stalks.“T6”-chickpea yogurt inoculated with green chilli stalks.“T7”-oat yogurt inoculated with red chilli stalks.“T8”-oat yogurt inoculated with green chilli stalks.

Table 2: pH values of different plant-based yogurt samples from various sources

Sample	Milk	Curd
Soya	6.50	4.36
Peanut	6.70	4.40
Chickpea	7.37	4.92
Oat	5.92	3.90

Nutritional profile

Different nutrients like protein, fat and ascorbic acid were estimated

The protein content in the yoghurt samples were determined by Formal titration (Pyne's method). Fat content in different yogurt samples were analysed by Soxhlet method using separating funnel. The ascorbic acid content in different yogurt samples determined by a redox titration using an iodine solution has been illustrated in the figure.

Statistical Data Analysis

One-way Analysis of Variance (ANOVA) was utilised to analyse the sensory attributes of soya yogurt, peanut yogurt, chickpea yogurt, and oat yogurt. Duncan's multiple range test ($p<0.05$) was used to compare the mean protein, lactic acid, and ascorbic acid content. A significant p-value of less than 0.05 was used for all analyses.

RESULTS

Sensory evaluation

Four types of plant yogurt samples were evaluated using chilli stalks in terms of color, aroma, taste, texture, mouth feel, and Overall Acceptability (OAA). Using a nine-point hedonic scale, ten consumers rated the samples (Table 1).

T1 (soya yogurt with red chili stalks) and T2 (soya yogurt with green chili stalks) consistently ranked higher in all attributes compared to the other samples, which was statistically significant. T3 (peanut yogurt with red chili stalks) and T4 (peanut yogurt with green chili stalks) had lower scores in flavor, mouth feel, and overall acceptability, which were significantly different from the soya-based samples. T5 (chickpea yogurt with red chili stalks) and T6 (chickpea yogurt with green chili stalks) also ranked lower in terms of sensory qualities, with T5 being slightly more favored than T6. T7 (oat yogurt with red chili stalks) and T8 (oat yogurt with green chili stalks) were rated the lowest in flavor and overall acceptability, significantly differing from the soya-based yogurts.

Chemical analysis

Determination of prepared yogurts pH

Overall, all yogurt samples produced exhibited a decrease in pH compared to their milk counterparts (Table 2).

Titratable acidity of the yogurts

Chickpea yogurt exhibited the highest lactic acidity, while oat yogurt displayed the lowest, as shown in Figure 1.

Lactic acid is generally produced by *Lactobacillus* bacteria. However, the plant-based milk samples do not contain LAB. The lactose-free milk was fermented using chili stalks that act as a source of LAB which converts the carbohydrates (maltose, sucrose) present in the milk into lactic acid. Therefore, the presence of lactic acid in the sample lowers the pH and increases the acidity indicating that fermentation has taken place; lactic acid is produced only when the substance undergoes fermentation. The presence of lactic acid and Capsaicin content makes it unfavourable for the growth of undesirable and pathogenic organisms as it exhibits antimicrobial activity against spoilage and pathogenic bacteria. Hence, it acts a preservative and contributes to its shelf life. From the results recorded both red and green chili stalks were found to contain a significant amount of LAB which is responsible for fermentation. Store-bought yogurts used as controls contained active live cultures of LAB.

Nutritional profile

Estimation of protein

A peculiar result was observed in the protein content of different yogurt samples (Figure 2).

The Red chili stalks cultured Soya Yogurt (RSY) (9±0.01)/100 g contained higher amount of protein when compared to Control Soya Yogurt (CSY) (8.82±0.02)/100 g and Green chili stalk cultured Soya Yogurt (GSY) (6.08±0.0351)/100 g which was recorded to have the least amount. Similar results were observed in the protein content of the peanut yogurt in Red chili stalks cultured Peanut Yogurt (RPY) (7.63±0.0152)/100 g, Green chili stalks cultured Peanut Yogurt (GPY) (5.14±0.0208)/100 g and Control Peanut Yogurt (CPY) 7.13±0.0152/100 g. Whereas the protein content in oats and chickpea yogurt varied when compared to soya and groundnut yogurt where the Green chili stalks cultured Oats Yogurt (GOY) (3.72±0.02)/100 g had a higher protein content than Red chili stalks cultured Oat Yogurt (ROY) (3.42±0.0264) and Control Oat Yogurt (COY) (3.42±0.02)/100 g which had the least amount. Green chili stalks cultured Chickpea Yogurt (GCY) 6.11±0.01/100 g, Red chili stalks cultured Chickpea Yogurt (RCY) (5.43±0.0264)100 g and Control Chickpea Yogurt (CCY) (4.53±0.0721)/100 g.

In the starter culture, lactic acid bacteria produce lactic acid, which coagulates milk protein into yogurt. The growth and metabolism of LAB during fermentation are the dominating factors for protein aggregation and texture of the yogurt. The protein content in the milk thickens the yogurt by coagulating and forming a three-dimensional mesh when exposed to lactic acid. Proteolysis is one of the key processes for the texture and flavour-forming process. Soya yogurt was high in protein content and low in saturated fats as the fermentation through enzyme bioactivity leads to the production of bioactive peptides.

Estimation of fat

The results estimated show that fat content in peanut yogurt was 25.51 g/100 g which was higher than that of oat yogurt that contain 19.84 g/100 g fat followed by chickpea yogurt containing

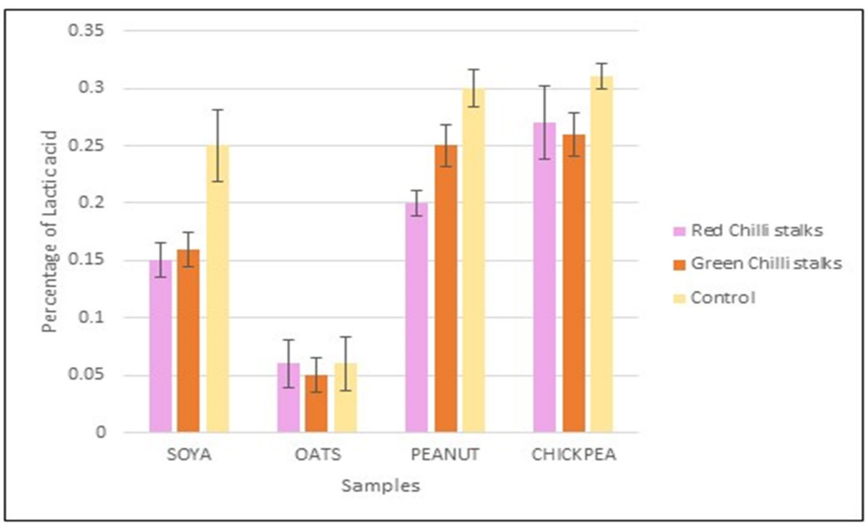

Figure 1: The data of Lactic acid percentage in four different plant-based yogurts.

Table 3: Qualitative analysis of Carbohydrates in four different plant-based yogurts.

Tests	Soya yogurt	Peanut yogurt	Chickpea yogurt	Oat yogurt
Molisch Test	+	+	+	+
Fehling's Test	+	-	+	+
Silver mirror test	+	-	+	+
Iodine test	-	+	+	+
Benedict's test	+	-	+	+
Barfoed's test	-	-	-	-
Bail's test	-	-	-	-
Seliwanoff's test	-	-	-	+

"+": positive result; "- " : negative result.

14.17 g/100 g fat and the least fat content was recorded in soya yogurt with 2.83 g/100 g (Figure 3).

Estimation of Ascorbic acid

A general trend of ascorbic acid content was observed by inoculation with red and green chili stalks in all the yogurt samples produced. The Red chili stalks cultured Soya Yogurt (RSY) (5.47 g±0.0290)/100 g was found to have a higher ascorbic acid content than that of green chili stalks cultured soya yogurt (GSY) (5.29±0.0077)/100 g and the least was in Control Soya Yogurt (CSY) (4.42±0.0484)/100 g. Similarly, Peanut Yogurt inoculated with Red chili stalks (RPY) (5.29±0.0119)/100 g was higher than Green chili stalks cultured Peanut Yogurt (GPY) (4.24±0.0151)/100 g and Control Peanut yogurt (CPY) (4.21±0.0146)/100 g which had the same value. Red chili stalks cultured Chickpea Yogurt (RCY) (4.40±0.0071)/100 g had higher ascorbic acid content than Green chili stalks cultured Chickpea Yogurt (GCY) (3.54±0.0406)/100 g and Control Chickpea Yogurt (CCY) (3.11±0.1095)/100 g. Ascorbic acid content in Red chili stalks cultured Oat Yogurt (ROY) (2.83±0.0237)/100 g was higher than Green chili stalks cultured Yogurt (GOY) (1.58±0.0038)/100 g and Control Oat Yogurt (COY) (1.26±0.0322)/100 g (Figure 4).

Soya yogurt inoculated with the chilli stalks was recorded to have the highest value due to the additive effect of high ascorbic acid content in both soya milk and chilli stalks. It was found that red chili stalks had a greater ascorbic acid content than green chili stalks; the ascorbic acid content increased with ripening. The control samples contained least amount of ascorbic acid. Ascorbic acid helps in the curdling of milk, and this curdled milk can be used as a starter culture for subsequent curd generations. Ascorbic acid acts as an antioxidant that enhances the nutritional status of the chilli stalk inoculated yogurt to the dairy yogurt

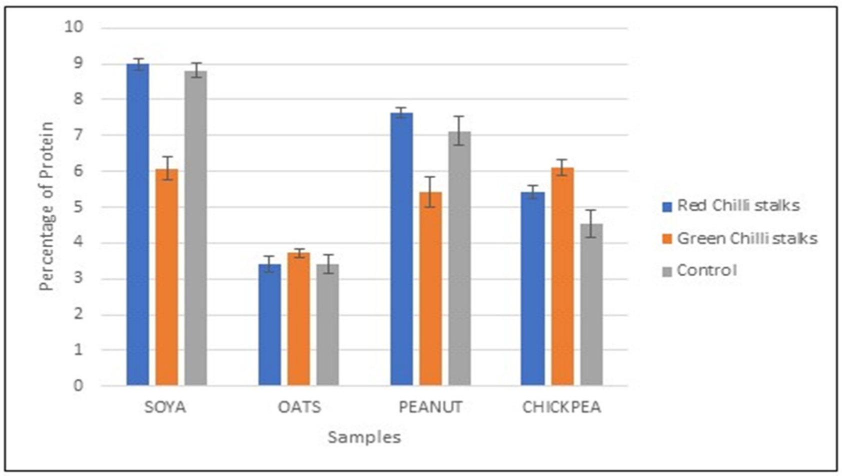

Figure 2: The data of Protein percentage in four different plant-based yogurts.

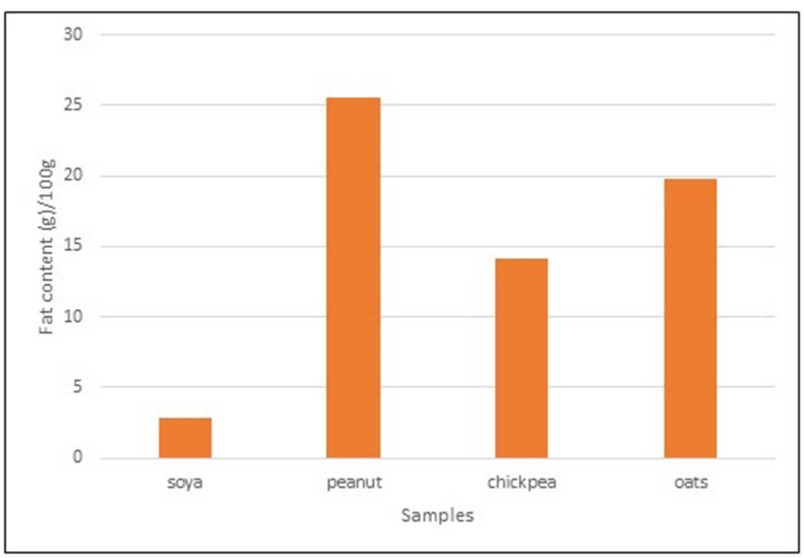

Figure 3: The data of fat content in four different plant-based yogurts.

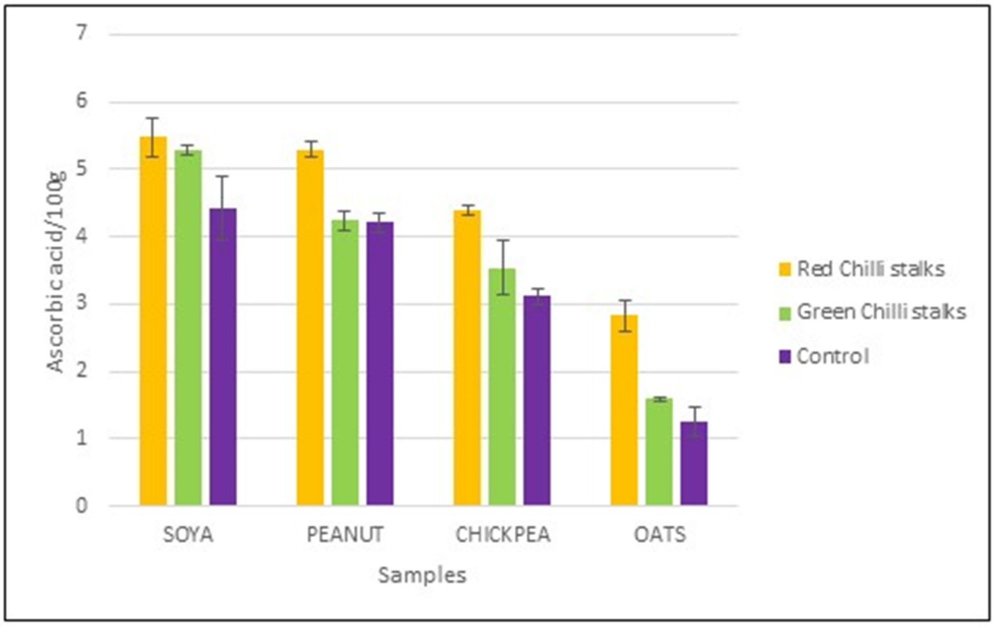

Figure 4: The data of Ascorbic acid content in four different plant-based yogurts.

and also it acts as a preservative. Thus, providing an unlimited amount of yogurt starter. Additionally, ascorbic acid is an oxygen scavenger and hence it increases the survival rate of LAB which prefers an anaerobic environment.

Qualitative analysis of Carbohydrate

All the yogurt samples showed positive results for Molisch test, confirming the presence of reducing sugars. Various qualitative tests were also performed to analyse the presence of different carbohydrates present the yogurt samples (Table 3).

The information presented here shows that the chilli stalks used to ferment the plant-based milks into yogurt, were responsible for the decrease in pH and increased titratable acidity in yogurt. As result the chilli stalks act as a cheap, easily available and nutritionally enriched alternative to the dairy yogurt starter. Out of the four samples used in the study, soya yogurt was concluded to confer better nutritional benefits in comparison to peanut, chickpea and oat yogurt. The red chilli stalk was a better inoculum for producing starter culture. The study hereby recommends well conducted RCTs in order to provide substantial proof for the health benefits of the plant-based yogurts inoculated with the chilli stalks. Further research on the characterization and isolation microorganisms from stalks of chilli with beneficial properties that are responsible for fermentation are hereby recommended.

DISCUSSION

This study investigates the potential of using chili stalks as a natural starter culture for the fermentation of plant-based milks (soy, peanut, chickpea, and oat) into vegan yogurt. Chili stalks, typically discarded as waste in the chili farming industry, were found to contain significant amounts of Lactic Acid Bacteria (LAB), which are essential for fermentation. The findings highlight the feasibility of utilizing chili stalks as a cost-effective, sustainable source of LAB, as well as a nutritious alternative to commercial starter cultures.

Fermentation involves the conversion of carbohydrates like maltose and sucrose into lactic acid by LAB, which lowers pH and increases acidity, confirming the success of the process. In this study, the plant-based milks fermented with chili stalks exhibited desirable traits such as lower pH and higher acidity. These changes indicate effective fermentation and suggest that chili stalks played a key role in producing lactic acid, which helps preserve the yogurt by inhibiting spoilage and pathogenic bacteria, thus enhancing its shelf life.[25]

Another key finding is the nutritional enhancement achieved through fermentation with chili stalks. Soy Yogurt inoculated with red chili stalks (RSY) exhibited the highest protein content (9±0.01 g/100 g), followed by Peanut Yogurt with Red chili stalks (RPY) (7.63±0.0152 g/100 g). This aligns with previous research that shows soy milk, a rich source of plant protein, improves protein digestibility and bioavailability through fermentation.[26] The higher protein content in RSY can be attributed to the proteolytic activity of LAB during fermentation, which breaks down proteins into more digestible forms.[27] Moreover, red chili stalks, rich in LAB, might have contributed to protein aggregation, further increasing protein content in soy yogurt.

Fat content varied among the different plant-based milks, with peanut yogurt showing the highest fat content (25.51 g/100 g), followed by oat yogurt (19.84 g/100 g). Soy yogurt had the lowest fat content, consistent with soy milk's natural composition as low-fat plant-based milk.[27] Peanut milk is known for its high-fat content, especially unsaturated fatty acids, which benefit cardiovascular health.[28] The fat in oat milk contributes to its smooth texture and creaminess.[29] These findings highlight how the nutritional profiles of different plant-based milks are reflected in the final yogurt product, offering various options for consumers seeking specific dietary needs, such as low-fat alternatives.

Ascorbic acid (Vitamin C) also played a significant role in the fermentation process. Soy yogurt inoculated with red chili stalks had the highest ascorbic acid content, due to the combined effect of ascorbic acid from both soy milk and chili stalks. Ascorbic acid not only aids in curdling but also acts as an antioxidant and preservative, enhancing the yogurt's nutritional profile and shelf life. Additionally, ascorbic acid scavenges oxygen, creating an anaerobic environment that promotes LAB survival during fermentation.[30] The increased ascorbic acid content in red chili-stalk inoculated yogurts could also contribute to the preservation of the yogurt's sensory properties, promoting its overall sensory appeal.[31]

Sensory evaluations indicated that Soy-based Yogurts (RSY and GSY) were preferred over other plant-based yogurts in terms of color, flavor, and overall acceptability. Soy yogurt, when fermented, develops a more palatable flavor and texture, making it more acceptable to consumers. This preference for soy yogurt aligns with findings from various studies on fermented soy products, which report improved taste and texture following fermentation.[32] In contrast, oat yogurt received the lowest sensory ratings, likely due to the natural taste and texture of oat milk, which can sometimes result in a less desirable mouthfeel when converted into yogurt.[33] The preference for soy yogurt may also reflect consumer familiarity with soy-based products, which are widely available in the market.[34]

The lactic acid production during fermentation was particularly evident in all plant-based yogurts. Soy Yogurt (RSY) showed the greatest decrease in pH, reaching 4.36, which indicates effective fermentation. Chickpea yogurt exhibited the highest titratable acidity, indicating high LAB activity. Previous studies suggest that legumes like chickpeas offer an ideal substrate for LAB fermentation, supporting microbial growth due to their carbohydrate profile.[35] Reduced pH and increased acidity also suggest the preservative effects of LAB, as acidification helps inhibit the growth of spoilage organisms, contributing to yogurt's shelf stability.[36]

An important finding is the use of chili stalks as a natural and cost-effective source of LAB, offering a sustainable solution to utilizing agricultural waste. The chili stalks used in this study contain various LAB strains that are effective in fermenting plant-based milks into yogurt, contributing to the development of yogurt with probiotic properties. This innovative approach aligns with sustainability in food production by reducing agricultural waste and providing a new market for chili stalks.[37]

The environmental benefits of using plant-based milks, such as soy, peanut, and chickpea, were also evident in this study. The production of plant-based milk requires less water and land compared to dairy milk, reducing greenhouse gas emissions.[38] As more consumers shift to plant-based diets, this study's findings could help promote sustainable, health-conscious alternatives to dairy products.[39] The use of chili stalks as a starter culture further enhances the sustainability of the production process, making it a promising approach to reducing the environmental impact of food production.

CONCLUSION

In conclusion, this study suggests that chili stalks can serve as an effective, sustainable starter culture for fermenting plant-based milks into yogurt. Red chili stalks, in particular, enhance the nutritional value of the yogurt, increasing protein, fat, and ascorbic acid content. Soy yogurt inoculated with red chili stalks showed superior nutritional benefits, making it a promising option for consumers seeking plant-based, probiotic-rich foods. Future studies should focus on the scalability of this method and its potential health benefits through clinical trials. This research highlights the potential of chili stalks as a valuable, sustainable resource in food production, offering enhanced nutritional properties and supporting the shift toward plant-based diets

ACKNOWLEDGEMENT

The authors ate thankful to Jyoti Nivas College Autonomous for providing facilities to carry out the experiments in the Zoology and Genetics laboratory.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Ponnamma Madaiah-Planning the research, data collection and analysis, drafting of manuscript. Poojitha Kishore- Data collection, analysis, interpretation of chickpea curd. Rakshitha K Ravi-Data collection, analysis and interpretation of data of peanut curd. Swathi Deepak Nayak-Data collection, analysis and interpretation of data related to oat curd. S. Soumya Kallekkattil-Guiding and supervising the research and Proofreading of manuscript.

SUMMARY

The research paper "Nutritional Comparison of Vegan Yogurts Prepared using Non-dairy Lactic Acid Bacteria (LAB)" explores the use of chili stalks as a natural starter for fermenting plant-based milks into yogurt. These milks-soy, peanut, chickpea, and oat-offer various nutritional and environmental advantages over dairy milk. The study evaluates the nutritional content and fermentation effectiveness of yogurt samples prepared using both red and green chili stalks. The study concludes that soy yogurt prepared with red chili stalks offers superior nutritional benefits compared to peanut, chickpea, and oat yogurts. It also highlights the potential of chili stalks as an economical and sustainable alternative to commercial yogurt starters. Further research is recommended to isolate and characterize the beneficial microorganisms responsible for fermentation in chili stalks.

REFERENCES

1. Olalekan AJ, Olatide M, M. Tech AJo, Oo G, Ab. A Pilot study on chilli stalks as a source of non-dairy lactic acid bacteria in yogurt making. In Appl Food Sci J. 2010;3:5-8.
2. Raj T, Chandrasekhar K, Kumar AN, Kim SH. Recent biotechnological trends in lactic acid bacterial fermentation for food processing industries. Systems Microbiol and Biomanufacturing. 2022;2:14-40.
3. Grujović MŽ, MLadenović KG, Semedo-Lemsaddek T, Laranjo M, Stefanović OD, Kocić-Tanackov SD. Advantages and disadvantages of non-starter lactic acid bacteria from traditional fermented foods: Potential use as starters or probiotics. Comprehensive Reviews in Food Sci and Food Safety.2022;21: 1537-67.
4. Malagón-Alvira, KO, Peredo-Lovillo A. *Capsicum* fruits as functional ingredients with antimicrobial activity an emphasis on mechanisms of action. J of Food Sci and Technol. 2022;60:1-2.
5. Kolea, Z, AAC. Kristi S, Will B Scott, Anne P. Fungal Seed Pathogens of Wild Chili Peppers Possess Multiple Mechanisms to Tolerate Capsaicinoid. Applied and Envmentl Microbiol. 2020;86:1697-19.
6. Wang F, Xue Y. Fu L, Wang Y. He, M. Zhao, X, Liao. Extraction, purification, bioactivity and pharmacological effects of capsaicin: a review. Critical Reviews in Food Sci and Nutrition. 2022;62:5322-48.
7. Yakuth SA, Taqui SN, Syed UT, Syed AA. Nutraceutical industrial chillies stalk waste as a new adsorbent for the removal of acid violet 49 from water and textile industrial effluent: Adsorption isotherms and kinetic models. *D*esalination and Water Treatment. 2019;155:94-112.
8. Chalupa-Krebzdak, S, Long CJ, Bohrer. Nutrient density and nutritional value of milk and plant-based milk alternatives. Int dairy j. 2018;87:84-92.
9. Bridges M. Moo-ove over, cow's milk. The rise of plant-based dairy alternatives. Practical Gastroenterology. 2018;21:20-7.
10. Villa C, Costa J, Oliveira MBP, Mafra I. Bovine milk allergens: A comprehensive review. Food Scie and Food Safety. 2018;17:137-64.
11. De, B., and T.K. Goswami: Micronutrient Fortification in Foods and Soy Milk, a Plant-based Milk Substitute as a Candidate Vehicle: Current Nutrition and Food Sci. 2022;18:739.
12. Arshad M Z, Sharmeen A, Nawaz, Iqbal A. Physical and Sensory Evaluation of Peanut Yogurt: Diet Factor. J. of Nutritional and Food Sci. 2022;3:259.
13. Kaur R, Prasad K. Technological, processing and nutritional aspects of chickpea (Cicer arietinum)-A review: Trends in Food Sci and Technol. 2021;109:448-63.
14. Zhang X, Tian W, Xie B, Sun Z. Insight into the Influence of Lactic Acid Bacteria Fermentation on the Variations in Flavor of Chickpea Milk. Foods. 2022;11:2445.
15. Silva ARA, Silva MMN, Ribeiro BD. Health issues and technological aspects plant-based alternative milk. Food Res In. 2020;131:1-2.
16. Biel W, Kazimierska K, Bashutska U. Nutritional Value of Wheat, Triticale, Barley and Oat Grains. Acta Scientiarum Polonorum Zootechnica. 2020;19:19-28.
17. Krishi Vidyapeeth M, Gadhe IK, Shaikh IR. Studies on quality evaluation of OAT milk. J of Pharmacognosy and Phytochem. 2020;9:2275.
18. Gupta S, Bisla G. Nutritional and sensory characteristics of oat milk based yoghurt. Int J of Applied Home Sci. 2019;6:261-5.
19. Cooper H, Rivero-Mendoza D, Dahl WJ. Plant-Based Milks: Oats. EDIS. 2020;5:11-4.
20. Farinde E, Obatolu VA, Fasoyiro SB, Adeniran AH, Agboola. Use of alternative raw materials for yoghurt production. African J of Biotechnol. 2008;7:3339-45.
21. Yadav DN, Singh KK, Bhowmik SN, Patil RT. Development of peanut milk-based fermented curd. Int J of Food Sci and Technol. 2010;45:2650-2.
22. Ani E, Amove J, Igbabul B. Physicochemical, Microbiological, Sensory Properties and Storage Stability of Plant-based Yoghurt Produced from Bambaranut, Soybean and *Moringa oleifera* Seed Milks. American J of Food and Nutrition. 2018;6:115-25.
23. Zhang X, Xie SB, Sun Z. Influence of lactic acid bacteria fermentation on physicochemical properties and antioxidant activity of chickpea yam milk. J of Food Quality. 2021;1-3.
24. Salehi B, Hernández-Álvarez AJ, del Mar Contreras M, Martorell M, Ramírez-Alarcón K, Melgar-Lalanne G, Sharifi-Rad J. Potential phytopharmacy and food applications of *Capsicum* spp.: A comprehensive review. Nat Product Communications. 2018;13:2.
25. Olatide M, Arawande JO, George OO, *et al.* Pilot study on chilli stalks as a source of non-dairy lactic acid bacteria in yogurt making. Appl Food Sci J. 2019;3(1):5-8.
26. Md. Anisur Rahman Mazumder, Anjuman Ara Begum. Pilot study on chilli stalks as a source of non-dairy lactic acid bacteria in yogurt making. Int J Adv Sci Technol Res. 2016;5(6):1-4.
27. Feng X, Ng K, Ajlouni S, Zhang P, Fang Z. Effect of Solid-State Fermentation on Plant-Sourced Proteins: A Review. Food Rev Int. 2023;40(9):2580-617. https://doi.org/10.1080/87559129.2023.2274490.
28. Arya SS, Salve AR, Chauhan S. Peanuts as functional food: a review. J Food Sci Technol. 2016;53(1):31-41. doi: 10.1007/s13197-015-2007-9. Epub 2015 Sep 19.
29. Cui L, Jia Q, Zhao J, Hou D, Zhou S. A comprehensive review on oat milk: from oat nutrients and phytochemicals to its processing technologies, product features, and potential applications. Food Funct. 2023;14(14):2955-67.
30. Gęgotek A, Skrzydlewska E. Antioxidative and Anti-Inflammatory Activity of Ascorbic Acid. Antioxidants (Basel). 2022;11(10):1993. doi: 10.3390/antiox11101993.
31. Owk AN, Kumar S, Subba T. Ascorbic Acid Contents in Chili Peppers (*Capsicum* L.). Not Sci Biol. 2009;1(1):50-2.
32. An F, Wu J, Feng Y, Pan G, Ma Y, Jiang J, Yang X, Xue R, Wu R, Zhao M. A systematic review on the flavor of soy-based fermented foods: Core fermentation microbiome, multisensory flavor substances, key enzymes, and metabolic pathways. Compr Rev Food Sci Food Saf. 2023;22(4):2773-801. doi: 10.1111/1541-4337.13162.
33. Brückner-Gühmann M, Benthin A, Drusch S. Enrichment of yoghurt with oat protein fractions: Structure formation, textural properties and sensory evaluation. Food Hydrocolloids. 2023;86(2-3):1-13.
34. Gupta MK, Torrico DD, Ong L, Gras SL, Dunshea FR, Cottrell JJ. Plant and Dairy-Based Yogurts: A Comparison of Consumer Sensory Acceptability Linked to Textural Analysis. Foods. 2022;11(3):463. https://doi.org/10.3390/foods11030463.
35. Grasso N, Alonso-Miravalles L, O'Mahony JA. Composition, Physicochemical and Sensorial Properties of Commercial Plant-Based Yogurts. School of Food and Nutritional Sciences, University College Cork. 2023;T12 Y337 Cork, Ireland.
36. Ibrahim SA, Ayivi RD, Zimmerman T, Siddiqui SA, Altemimi AB, Fidan H, Esatbeyoglu T, Bakhshayesh RV. Lactic Acid Bacteria as Antimicrobial Agents: Food Safety and Microbial Food Spoilage Prevention. Foods. 2021;10(12):3131. https://doi.org/10.3390/foods10123131.
37. Borthakur A, Borah S. Agricultural Waste Management: Sustainable Approaches for Environmental Conservation. Curr Trends Agric Allied Sci. 2023;2(1):68-72.
38. Kanyama C, Hedin B, Katzeff C. Differences in Environmental Impact between Plant-Based Alternatives to Dairy and Dairy Products: A Systematic Literature Review. Sustainability. 2021;13(22):12599. https://doi.org/10.3390/su132212599.
39. Husna SA, Sultana N. Evolution, Growth, and Consumer Preferences of Plant-Based Alternatives in India. Madhya Bharti. 2022;82(14):78-90.

Cite this article: Madaiah P, Kishore P, Ravi RK, Nayak SD, Kallekkattil S. Nutritional Comparison of Vegan Yogurts Prepared Using Non-Dairy Lactic Acid Bacteria. Asian J Biol Life Sci. 2025;14(1):119-26.