International Journal for Holistic Research, Vol. 2, No. 2. Jan 2025

OPEN ACCESS

Print ISSN: 3009-6898
Online ISSN: 3009-6790

The Influence of Probiotic Fermented Jerusalem Artichoke *(Helianthus Tuberosus* L) on the Quality of Milk Products by Lactic Acid Bacteria

Momen J. Ali[1], Fekria M. Ali[1], Hala A. Abd-Elal[2], Hala Hassan Elsayed[1]
[1] Food Processing Technology Department, Faculty of Organic Agriculture, Heliopolis University,
[2] Department of Sustainable Development of Environment and Its Projects Management, Environmental Studies & Research Institute, University of Sadat City

*** Corresponding author Prof. Dr. Hala H. Elsayed , Email: hala.hassan@hu.edu.eg**
Article history: Received: 07-10-2024 Revised: 04-11-2024 Accepted: 26-11-2024

Abstract

Probiotic fermentation is a process that is widely used in the production of dairy products. The purpose of this study was to scrutinize the quality of milk products enriched with tubers of Jerusalem Artichoke (*Helianthus Tuberosus L*) fermented with lactic acid bacteria (*pediococcus pentosacues* (CCM822), and *Lactobacillus rhamnosus* (ATCC7469) to assess the effect of such a plant on the milk product. The results showed that the sensory analysis was affected not only by the characteristics of edible plant material but also by the LAB that used during fermentation which Showed different effects different effect on aroma, flavor, and appearance. The pH of milk and HT mixture was lower in pH from HT fermentation by the strains, however, show that the pH drops during fermentation the results showed that HT was higher in pH compared to HT without milk. However, the results of pH determination for HT by the isolates show that the significant drop in pH was in the domestic strain followed by fermentation with pp strain. These findings provide valuable insights for the dairy industry and consumers alike.

Key words: Probiotic, Fermentation, Milk product, *Helianthus Tuberosus L, pediococcus pentosacues, Lactobacillus rhamnoses,*

List of abbreviations:

HT: Helianthus Tuberosus**, LAB:** Lactic Acid Bacteria**, PP:** Pediococcus pentosacues**, LGG:** Lactobacillus rhamnosus**, pH:** Potential of Hydrogen

1-Introduction

Probiotic milk products enriched with different functional ingredients augment to be prominentProbiotics have a multitude of beneficial effects in human health, including immune system enhancement, treating diarrhea, treating inflammatory bowel diseases, such as Crohn's disease and ulcerative colitis, relieving from the symptoms of irritable bowel disease, preventing cancer, and lowering cholesterol [1]. Erectors intensify to produce products rich in beneficial ingredients and to be acceptable to consumers by achieving the best sensory characteristics. *Helianthus tuberoses* (HT) is one of the richest plants in biologically active compounds that were fermented with lactic acid bacteria (LAB) *(pediococcus pentosacues* (CCM822) PP, and *Lactobacillus rhamnosus* (ATCC7469) LGG). This plant was not used adequately for fermentation, especially with milk-based products. This is considered one of the fewest studies conducted to measure the influence of these beneficial plant tubers on milk product processing.

Cite this article: Momen J. Ali, Fekria M. Ali, Hala A. Abd-Elal, Hala H. Elsayed," The Influence of Probiotic Fermented Jerusalem Artichoke (Helianthus Tuberosus L) on the Quality of Milk Products by Lactic Acid Bacteria", International Journal for Holistic Research, Vol. 2, No. 2. Jan 2025. DOI: 10.21608/ijhr.2024.326621.1031

Helianthus tuberoses have a lot of benefits where it contains active compounds such as inulin which is used in the food industry and for other medical uses such lose weight and controlling diabetes. Inulin is used in food industry as dietary fiber with probiotic properties [2]. Furthermore, it is considered a fat replacer, HT an unconventional crop that has received attention in Egypt especially because of the high susceptibility in the different lands like in [3]. LAB has different uses involving fermented milk products. Lactic acid is a key metabolite produced during fermentation and in food products, it usually serves either as preservative or as flavoring agent like in [4]. LAB has a lot of benefits in the food industry in fermentation technology, its avail for the gastrointestinal tract, and has an antimicrobial effect. The intent of this study is to scrutinize the quality of milk products enriched with HT fermented with lactic acid bacteria .and to evaluate the effect of such a fermented plant on the milk product.

2-Materials and Methods:

2.1. Plant Materials

The tubers of *Helianthus tuberoses* were obtained from the Environmental Studies & Research Institute (ESRI), University of Sadat City (USC), Sadat City, Menoufia farm- Egypt and then the contents were analyzed. The tubers were found to contain 114 g kg^{-1} protein, moisture 192 g kg^{-1}, fat 10 g kg^{-1}, ash 58 g kg^{-1}, inulin 42 g kg⁻1 fresh weight [5]. The tubers were preached then distributed in trays put into the oven, drying at 60 powder. The HT powder is used for fermentation with strain isolates LAB.

2.2. Fermentation of plant material and milk

The fermentation of HT by LAB was obtained from (Cairo Mircen- Ain Shams University, Egypt) Isolates cultured in MRS broth media at +30°C for 48 hours [6]. After enrichment, strains were diluted with saline up to10^3 (CFU) mL^{-1}. Three hundred grams of HT were mixed with 450 mL of water, and 5 mL of pure cultures of microorganisms and fermented for 24 hours at +30° C. The fermentation process depends on various properties such as the fermentation conditions, type of strain used, plant composition, and bacterial byproducts, as supported by earlier studies in [7], [8].

2.3. Determination of pH

The pH measured for the samples by pH meter device, samples were measured at zero time and after one hour till the final fermentation ends. Samples were prepared into falcon tubes 10 ml in each tube. Measuring pH for liquids by pH meter is the most suitable method in [9]. The pH measurements were essential for assessing the fermentation process and the stability of the products, as described by early study in [2].

2.4. Determination of fat, ash, Fe, K, Ca, and moisture contents

Samples were dried at 70 °C for 72 hours 9HT and after the stable wt. of samples, the dry matter was calculated. The dry matter was ignition at 550 °C for 2 hours. To calculate the residual ash% according to the following method [10]. The dry matter was digested with enough H_2O_4 for 2 hours and then 2 ml of H_2O_2 followed the final addition of HCI until get clear solution as the following method of [10]. Metal determination by ICP-MS. The diluted Extracted samples were filtered through disposable 0.2 um PTFE syringe filters (DISMIC-25HP, Advantech, Tokyo, Japan. The metal concentrations in these extracts were determined by means of 15 inductively coupled plasma-mass spectroscopy (ICP-MS) (iCAP, Thermo, Germany). Certified reference materials (Merck, Germany) were included in the analyses. The recovery of metals was within the certified limits. Qtegra software was used for average and relative standard deviation calculation [11].

2.5. Determination of carbohydrates, inulin and fructose

Samples were dried at 70 °C for 72 hours. and after stable wt. of samples, dry matter was calculated. The dry matter was ignition at 550 °C for 2 hours, to calculate the residual ash% as following method in [10]. Samples digested the dry matter was digested with enough H_2O_4 for 2 hours, and then 2 ml of H_2O_2 followed the final addition of HCI until get clear solution; following method of alike study in [10].

2.6. Sensory evaluation analysis

The sensory evaluation had been conducted at (Heliopolis University, Cairo-Egypt) by making a taste banal and sensory evaluation sheet, it was prepared to evaluate consumer acceptance and measure the (flavor, texture, appearance, and aroma). The results were analyzed to determine consumer acceptance and preferences, in line with methodologies established in early study [10].

3- Result and Discussion

3.1. Determination of Nutritional analysis

The analysis of different samples determined a wide difference in concentration of inulin, fructose and fiber as mentioned in Table (1), it was found that there were no differences between HT-lactobacillus, HT-Pediococcus, and HT- domestic regarding ash and Fe contents, while significant differences in the contents of fat, fiber, inulin, phenolic compounds, Na, Mg, K and Ca. Also, the results indicated that there were differences between HT-*lactobacillus* and HT-*Pediococcus* versus HT-domestic regarding the levels of carbohydrate and protein. Additionally, significant differences were observed between HT-*Pediococcus* and HT- domestic versus HT- *lactobacillus* regarding the level of fructose. HT- domestic was found to contain high levels of fat, Protein, fiber, phenolic compounds, Fe, Na, Mg, K, and Ca, whereas the higher levels of Carbohydrate and Fructose were recorded for HT- *lactobacillus*. For HT-*Pediococcus* was found to have the highest level of Inulin. These differences highlight the varying nutritional profiles of the samples across different parameters. The Jerusalem artichoke fermented with Lactobacillus rhamnosus showed increased levels of protein and inulin compared to the domestic strain, consistent with findings in [12]. The results suggest that the incorporation of Jerusalem artichoke enhances the nutritional profile of the milk products.

3.2 Determination of pH

The determination of pH samples for HT fermented by different strains of lactic acid bacteria (*Pediococcus Pentosacues, Lactobacillus rhamnosus* and Domestic strain) showed a difference in pH ranges as shown in Table (2) the pH drops during fermentation the results, however, show that HT with milk was lower in pH from HT fermented by the strains. The P. *pentosacues* showed the most significant drop in pH 4.6 rather than the other samples, the L. *rhamnosus* was 4.7 also the domestic strain was 4.8 on the other hand, the samples. of the fermented HT by the isolates show that the significant drop in pH was in the domestic strain followed by fermented HT with (*pediococcus p)* strain this could be shown in Table (2). This decline in pH is crucial for product preservation, supporting the findings in [4], which indicate that lactic acid production enhances the stability of fermented products. Fermentation phases depend on different properties such as the fermentation conditions, type of strain used, plant composition and bacterial products due to the synthesion of material components [7].

3.3 Sensory evaluation analysis

The sensory evaluation demonstrated that the probiotic milk products were well-received by consumers, with significant improvements in flavor and aroma noted [13]. The incorporation of Jerusalem artichoke and lactic acid bacteria not only enhanced the nutritional quality of the products but also improved their sensory attributes, making them more appealing to consumers, as supported by previous study [14]. The fermentation process known to make a change in fermented products not only the product physical characteristics like (texture, aroma, color...etc.) but also affect the product chemical characteristics like (lowering acidity). After conducting the sensory analysis for HT fermented milk (pediococcus pentosacues) was the most favorable, as shown in Figure (1) also, It can be noted that the differences in the texture, flavor and color shown in Table (3), this could be defined by it being less smooth than samples (A& D) Figure (2) pageants the external flavor for it. Furthermore, it had the most pleasant taste and aroma also in acidity.

Table 1: The nutritional composition of helianthus tubers with different bacterial strains

Unit	Composition	HT- lactobacillus	HT-Pediococcus	HT- domestic
g/100g	Ash	1.35	1.35	1.35
g/100g	Carbohydrates	78	76	68.2
g/100g	Fat	3.1	6.0	7.1
g/100g	Protein	4.1	4.0	10.1
g/100g	Fiber	2.5	3.5	4.4
g/100g	Inulin	1.3	7.5	6.7
g/100g	Fructose	31.1	27.0	27.6
g/100g	Phenols	6.1	5.0	8.5
ppm	Fe	99.9	103.9	104.9
ppm	Na	1897.6	1606.3	8048.8
ppm	Mg	244.9	161.2	385.8
ppm	K	419.7	187.0	483.1
ppm	Ca	3359.2	1734.7	6307.5

Table 2: Determination of pH for HT samples fermented with milk and different LAB strains

Time (hr)	Sample c1-A -HT with lactobacillus	Sample c2-C-HT with pediococcus	Sample c3-D – HT with domestic strain
0	6.61	6.49	6.50
1	6.01	6.22	6.50
2	5.59	5.91	5.88
3	5.42	5.54	5.20
4	4.91	4.76	4.78
24	4.71	4.65	4.87

Table 3: overall sensory evaluation results between the different samples

Sample	Flavor	Texture	Aroma	Appearance
sample HT-pediococcus	10	10	10	10
sample HT- lactobacillus	7	10	5	8
sample HT-domestic strain	8	10	7	8
Control	10	10	10	10

The sample fermented by *Lactobacillus rhamnoses* was the lowest favorable in aroma, maybe this because of the bacterial biproduct but it had neutral taste favorability. At this point the analysis shows that the sensory analysis is affected not only by the characteristics of edible plant material but also by the LAB that is used during fermentation which shows a different effect on aroma, flavor and texture. The findings indicated that the sensory attributes, including aroma, flavor, and appearance, were significantly influenced by both the characteristics of the plant material and the specific LAB used during fermentation [15].

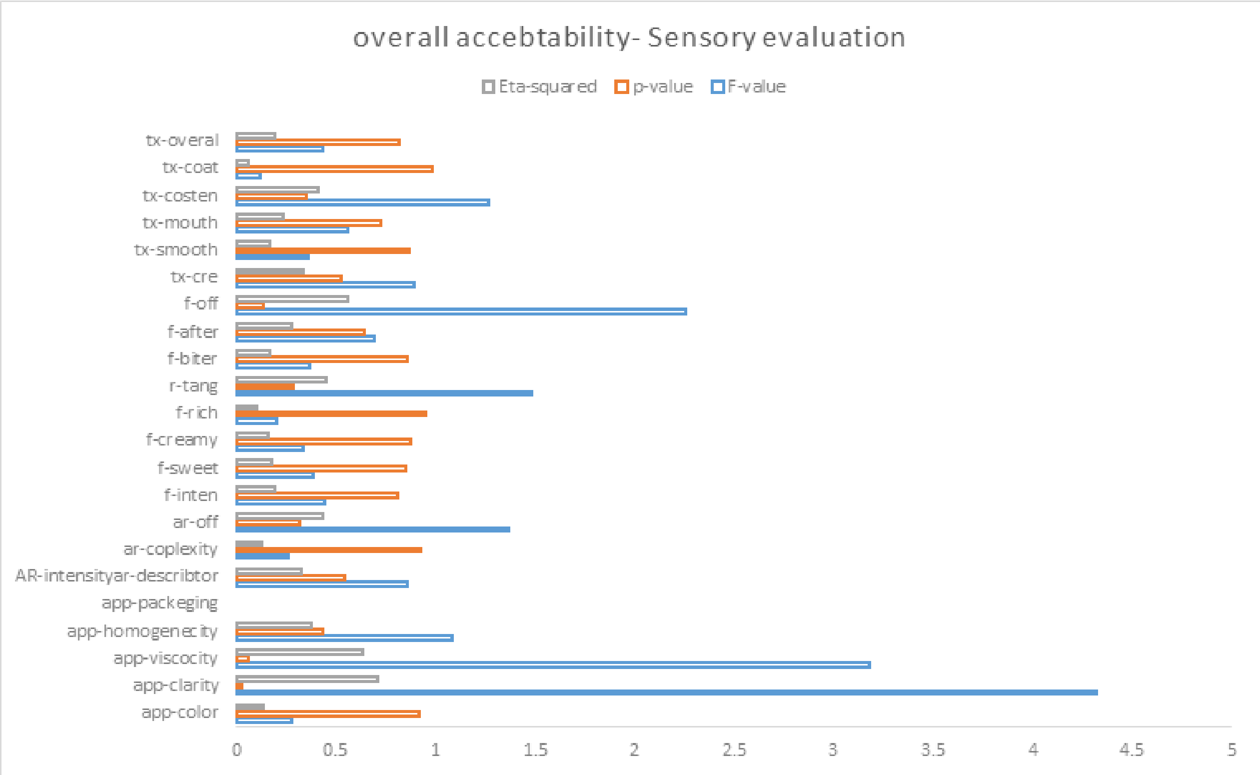

Figure 1: statistical analysis showing the differences between samples in sensory attributes

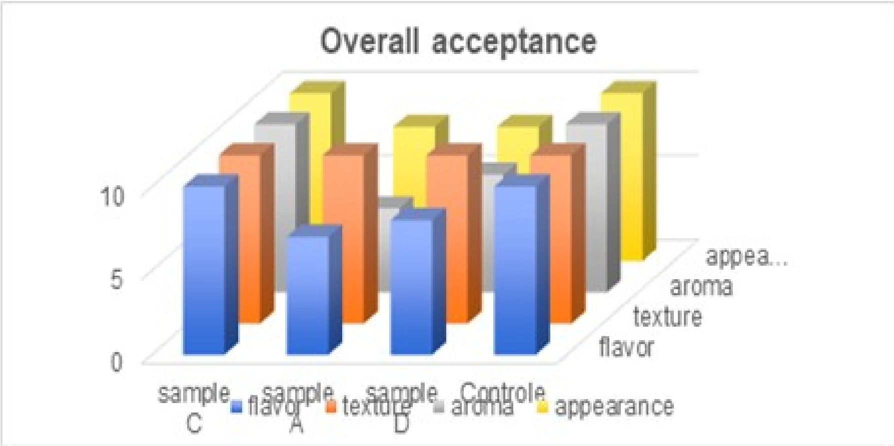

Figure 2: the overall sensory evaluation results for the samples.

4-Conclusion

In conclusion, the experimental studies on the influence of probiotic-fermented milk products enriched with *Helianthus Tuberoses* and fermented with lactic acid bacteria have demonstrated profound effects on the quality and nutritional composition of dairy foods. The incorporation of HT in milk products, fermented with specific LAB strains, has shown promising results in terms of sensory attributes, pH levels, nutritional composition, and shelf-life enhancement. The sensory evaluation revealed distinct characteristics in the fermented milk products, with *Pediococcus pentosacues* strain yielding the most favorable results, particularly in terms of smoothness, flavor, aroma, and acidity. The fermentation process also led to significant decreases in pH, particularly with the PP strain, indicating the activity of lactic acid bacteria in the production of organic acids. This activity, in turn, impacted on the nutritional composition of the milk products, resulting in altered fat, ash, carbohydrate, protein, and fiber content. Furthermore, the evaluation of health benefits associated with the consumption of these probiotic-fermented dairy foods demonstrated the potential for immune modulation, gut health enhancement, and disease prevention. The specific strains used in fermentation, such as PP and LGG, played crucial roles in providing essential nutrients and health Overall, these findings highlight the potential for incorporating probiotic fermentation, particularly with HT and specific LAB strains, in the production of milk products. The continued exploration of the influence of probiotic fermentation on sensory attributes and health benefits will undoubtedly contribute to the advancement of dairy product development and consumer satisfaction [16], [17], [18]. These insights are valuable to both the dairy industry and consumers, paving the way for the development of dairy foods with enhanced quality and significant health advantages as supported by findings from [19], [20].The continued exploration of the influence of probiotic fermentation on sensory attributes and health benefits will undoubtedly contribute to the advancement of dairy product development and consumer satisfaction.

References

[1] Hadjimbei, E., Botsaris, G., & Chrysostomou, S. (2022). Beneficial effects of yoghurts and probiotic fermented milks and their functional food potential. Foods, 11(17), Article 2691. https://doi.org/10.3390/foods11172691

[2] Roberfroid, M. (2000). Prebiotics and probiotics: Are they functional foods? Nutritional Research Reviews, 13(2), 189-200. https://doi.org/10.1017/S0954422400003007

[3] Surono, I. S., & Hosono, A. (2002). Fermented milks | types and standards of identity. Encyclopedia of Dairy Sciences, 1018–1023. https://doi.org/10.1016/b0-12-227235-8/00162-0

[4] Vuyst, L. D., & Vancanneyt, M. (2007). Lactic acid bacteria in food fermentations. In M. P. Doyle & L. R. Beuchat (Eds.), Food microbiology: Fundamentals and frontiers (3rd ed., pp. 185-207). ASM Press.

[5] Sawicka, B., Danilčenko, H., Jariene, E., Skiba, D., Rachoń, L., Barbaś, P., & Pszczółkowski, P. (2021). Nutritional Value of Jerusalem Artichoke Tubers (Helianthus tuberosus L.) Grown in Organic System under Lithuanian and Polish Conditions. Agriculture, 11, 440. https://doi.org/10.3390/agriculture11050440

[6] Shirai, K., Guerrero, I., Huerta, S., Saucedo, G., Castillo, A., Obdulia Gonzalez, R., et al. (2001). Effect of initial glucose concentration and inoculation level of lactic acid bacteria in shrimp waste ensilation. Enzyme. Microb. Tech. 28, 446–452. doi: 10.1016/s0141-0229(00)00338-0

[7] Szambelan, K., Nowak, J., & Chrapkowskaja, K.J. (2004). Comparison of the bacterial and yeast ethanol fermentation yield from Jerusalem artichoke (Helianthus tuberosus L.) tubes, pulp and juice.

[8] Gerasi, E., Litopoulo-Tzanetaki, E., & Tzanetakis, N. (2010). Microbiological study of Manura, a hard cheese made from raw ovine milk in the Greek island Sifnos. Int. J. Dairy Technol. 56, 117–122. doi: 10.1046/j.1471-0307.2003.00085.x

[9] Kulasekaran, G., Karthikeyan, K., & Suresh, S. (2015). A review on the methods of measuring pH in food products. *International Journal of Current Microbiology and Applied Sciences*, 4(5), 1-8.

[10] Lambers, H., Chapin, F. S., & Pons, T. L. (2008). Plant Physiological Ecology. Second Edition, Springer Science, LLC, New York, USA.

[11] American Public Health Association [APHA] (2017). Standard Methods for the Examination of Water, 23rd ed. APHA, Inc. Washington, D.C.

[12] Khalili, M., Rad, A., Khosroushahi, A., Khosravi, H., & Jafarzadeh, S. (2020). Application of probiotics in folate bio-fortification of yoghurt. Probiotics. Antimicro 12, 756–763. doi: 10.1007/s12602-019-09560-9567

[13] Martínez, M. P., Magnoli, A. P., González Pereyra, M. L., & Cavaglieri, L. (2019). Probiotic bacteria and yeasts adsorb aflatoxin M(1) in milk and degrade it to less toxic AFM(1)- metabolites. Toxicon, 172, 1–7. doi: 10.1016/j.toxicon.2019.10.001

[14] Kumariya, R., Garsa, A., Rajput, Y., Sood, S., Akhtar, N., & Patel, S. (2019). Bacteriocins: classification, synthesis, mechanism of action and resistance development in food spoilage causing bacteria. Microbial. Pathogenesis 128, 171–177. doi: 10.1016/j.micpath.2019.01.002

[15] Zalán, Z., Hudáček, J., Tóth-Markus, M., Husová, E., Solichová, K., Hegyi, F., Plocková, M., Chumchalová, J., & Halász, A. (2011). Sensorically and antimicrobially active metabolite production of Lactobacillus strains on Jerusalem artichoke juice. J Sci Food Agric, 91, 672–679.

[16] Segers, M. E., & Lebeer, S. (2014). Towards a better understanding of Lactobacillus rhamnosus GG--host interactions. Microbial cell factories, 13 Suppl 1(Suppl 1), S7. https://doi.org/10.1186/1475-2859-13-S1-S7

[17] Afinjuomo, F., Abdella, S., Youssef, S. H., Song, Y., & Garg, S. (2021). Inulin and Its Application in Drug Delivery. Pharmaceuticals (Basel, Switzerland), 14(9), 855. https://doi.org/10.3390/ph14090855

[18] Wang, Y., Wu, J., Lv, M., Shao, Z., Hungwe, M., Wang, J., Bai, X., Xie, J., Wang, Y., & Geng, W. (2021). Metabolism characteristics of lactic acid bacteria and the expanding applications in food industry. Frontiers in Bioengineering and Biotechnology, 9. https://doi.org/10.3389/fbioe.2021.612285

[19] Raman, M., Ambalam, P., Kondepudi, K. K., Pithva, S., Kothari, C., Patel, A. T., Purama, R. K., Dave, J. M., & Vyas, B. R. (2013). Potential of probiotics, prebiotics and synbiotics for management of colorectal cancer. Gut microbes, 4(3), 181–192. https://doi.org/10.4161/gmic.23919

[20] Shan, C., Li, M., Liu, Z., Xu, R., Qiao, F., Du, Z.-Y., & Zhang, M.-L. (2021). Pediococcus pentosaceus enhances host resistance against pathogen by increasing il-1β production: Understanding probiotic effectiveness and administration duration. Frontiers in Immunology, 12. https://doi.org/10.3389/fimmu.2021.766401