JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2015, 21(4), 309-314

Journal of Agroalimentary Processes and Technologies

A Traditional Fermented Product: Şalgam juice, production and usage

Derya Arslan, Ahmet Ünver, Mehmet Musa Özcan*

Department of Food Engineering, Faculty of Agriculture, Selçuk University, 42031 Konya, Turkey

Received: 27 July 2015; Accepted: 25 October 2015

Abstract

In this study chemical and microbiological profile of Şalgam juice produced by fermentation were investigated. Different sourdough compositions and starter culture (*L. plantarum*) concentrations in fermentation were used as leavening agents. Also the quality properties of end product were evaluated with sensory analysis. *L. plantarum* produced a greater amount of lactic acid (0.68-0.69) and reduced the pH of fermented Şalgam juice to below 3.5 after two weeks of fermentation. The initial lactic acid bacteria counts of *Lb. plantarum* (1%) and wheat flour + bulgour flour + sucrose combination added samples were higher (6.90-7 log cfu/ml, respectively) than the others. Molds-yeast numbers in these samples were significantly ($p<0.01$) low. Sensory evaluation showed that *Lb. plantarum* inoculation and also sucrose addition to the traditional sourdough formulation were favorable with respect to color, odor and taste.

Keywords: Şalgam juice; fermentation; starter culture

1. Introduction

Preservation of foods by fermentation is a widely practiced and ancient technology. Lactic acid bacteria because of their unique metabolic characteristics are involved in many fermentation processes of milk, meats, cereals and vegetables. The production of fermented foods is one of the oldest food processing technologies known to man. Şalgam juice is a red colored, turbid and sour drink. It is generally home produced [1,2]. Traditional foods and beveragres production is one of the oldes manufacturing and preservation methods, dating back to old days 1 [4]. Şalgam juice is a fermented beverage prepared from bulgour flour, water, black carrot, salt, sourdough and turnip [5]. Lactic acid bacteria and yeasts are the predominant microorganisms found in Şalgam juice [6].

At the end of fermentation Şalgam juice gets its red-purple color and sour taste. Turnip (*Brassica rapa* L.) is a root Brassica crop and has been used as a vegetable for human consumption since prehistoric times [7]. Traditionally fermented Şalgam juice should be consumed in a short time as it is a perishable product because of low salt content. It is not pasteurized and preservative agent is not used. Pasteurized Şalgam juice gets a boiled carrot flavor [2,7,8,9].

In many of these foods, the biological and microbiological bases of the fermentation processes are poorly understood. This study aimed to determine the role of different leavening agents with respect to their contribution to chemical and sensorial quality of the product.

Corresponding author: *e-mail:* mozcan@selcuk.edu.tr (M. Özcan).

2. Methodology

Preparation of samples. The fermentation of Şalgam juice was initiated by different sourdough formulations and starter cultures. Traditionally this sourdough was made of wheat flour, water, salt and bulgour flour. In this study seven different sourdough formulations and three *Lb. plantarum* concentrations (0.5, 0.75 and 1%) were tested. Sourdough types were prepared using bakers yeast, yogurt, sucrose and citric acid in addition to traditional sourdough ingredients. These ten different leavening agents are listed below:

- Wheat flour (%34) + bulgour flour (%64) + bakers yeast (%2) **(WF+BF+BY)**
- Wheat flour (%34) + bulgour flour (%64) + bakers yeast (%1) + yogurt (%1) **(WF+BF+BY+Y)**
- Wheat flour (%34) + bulgour flour (%64) + yogurt (%2) **(WF+BF+Y)**
- Wheat flour (%30) + bulgour flour (%60) + sucrose (%10) **(WF+BF+S)**
- Wheat flour (%30) + bulgour flour (%60) + yogurt (%3) + sucrose (%7) **(WF+BF+Y+S)**
- Wheat flour (%30) + bulgour flour (%60)+bakers yeast (%3) + sucrose (%7) **(WF+BF+BY+S)**
- Wheat flour (%30) + bulgour flour (%60) + bakers yeast (%2.9) + sucrose (%7) + citric acid (0.1 %) **(WF+BF+BY+S+CA)**
- Starter culture (*L. plantarum*, 0.5%)
- Starter culture (*L. plantarum*, 0.75%)
- Starter culture (*L. plantarum*, 1%)

50 g of prepared doughs were fermented in little lid jars individually and incubated at 28-30 ^{o}C for 2-3 days. These sourdoughs were put into 2 *l* jars containing washed, clarified and sliced black carrots and turnips. Pasteurized salt water (1%) was added onto the carrots and turnips. Starter culture concentrations were calculated according to volume of salt water added and the sourdoughs were added into the jars and jars were kept at 30 ^{o}C 2 weeks. The experiments were replicated two times.

Chemical analyses. The pH was determined with a pH meter (Sentix 41 electrode, WTW-315İSET). Titratable acidity was determined by titrating 10 ml of sample against 0.1 N NaOH to pH 8.5. The acidity was calculated as percent lactic acid equivalent. Acidity, pH and salt analysis were done according to *(10)*. Lactic acid bacteria (LAB), Total bacteria (TB), Coliform bacteria (CB) and Yeasts-Moulds (YM) numbers were determined according to *(11)*. Rogosa Agar, Potato Dextrose Agar, Plate Count Agar and Violett Red Bile Agar (Merck, Germany) were used for the determination of LAB, MY, TB and CB, respectively.

Sensory analysis. Sensory analysis was undertaken on the 4th week of fermentation by Puvan method for quantitative assessment of quality. The Puvan levels were: 5 very poor, 10 poor, 15 normal, 20 good and 25 perfect [12,13]. The sensory evaluation was performed by seven trained assessors and with experience at evaluating pickles.

Minitab 10.0 was performed on the replicates in order to obtain analysis of variance and mean differences determined by Duncan's multiple range.

3. Results and Discussion

Chemical analysis. Results of chemical analysis of samples were given in Figures 1, 2 and 3. The pH fell from 3.84-3.55 to 3.69-3.23 in 2 weeks with a simultaneous increase in titratable acidity from 0.28-0.38% to 0.42-0.69 lactic acid. There was a significant difference ($p<0.01$) in pH and acidity between the different sourdough compositions and starter culture concentrations in their ability to ferment the Şalgam juice. The lowest pH values and the most rapid drop in pH were observed in *L. plantarum* inoculated samples. The combination of WF+BF+BY+Y and WF+BF+Y showed the highest pH values during fermentation time. The starter cultures of all concentrations of *L. plantarum* were effective in fermenting the Şalgam juice as judged from the changes in pH and acidity (Figures 1 and 2). At the end of the second week the highest acidity values of starter culture inoculated samples and the low acidity of WF+BF+BY+Y were important. Results showed that saccharose containing sourdoughs produced more lactic acid than the others didn't contain saccharose. According to previous studies pH and titratable acidity (%) were ranged 3.33-3.85 pH and 0.35-0.96%, respectively [2,6,14].

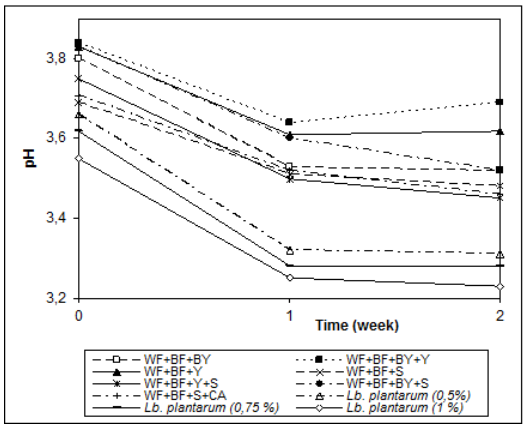

Figure 1. Change in pH in Şalgam juice during fermentation

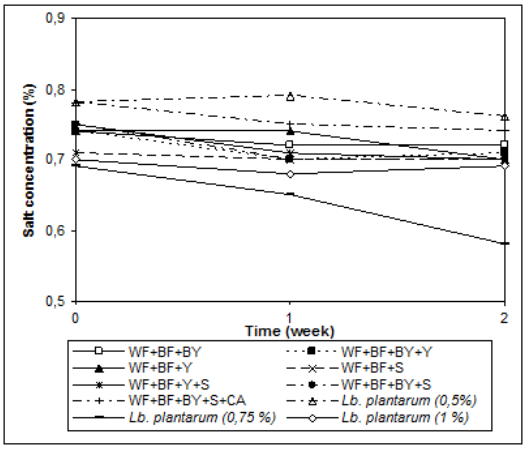

Figure 2. Change in titratable acidity in Şalgam juice during fermentation.

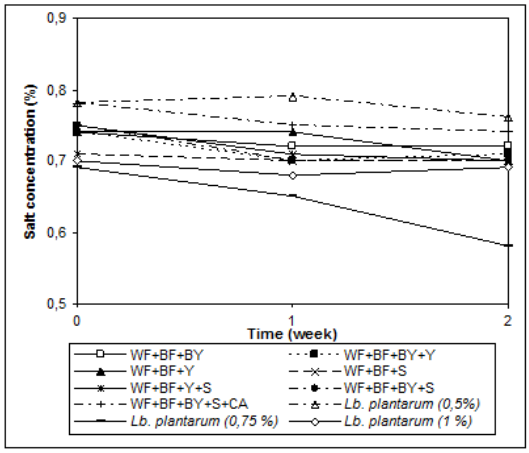

Figure 3. Change in salt concentration in Şalgam juice during fermentation

The initial salt amount of water, 1% (w/v), decreased to min.0.58% and max.0.74% due to the transition of water in black carrot to water in the medium. Generally the salt amount of commercial Şalgam juice doesn't exceed 2% [15]. This decrease in salt concentration depends on the amount of black carrot put into jars.

Microbial numbers. The microbial profile changes seen in Figures 4, 5, 6 and 7 indicate that in the beginning of fermentation 1% *Lb. plantarum* and WF+BF+S combinations exhibited the highest LAB growth (7 log cfu/ml). Also saccharose containing sourdoughs, except citric acid added one (WF+BF+BY+S+CA) had high LAB counts at the beginning. But, these high LAB counts decreased to about 4 log cfu/ml on the 2nd week of fermentation period. In starter culture inoculated samples, much more decrease in LAB counts were observed. These could be attributed to the high lactic acid formation in these samples. But, there was no significant difference between the ten different combinations in the 2nd week (Figure 4).

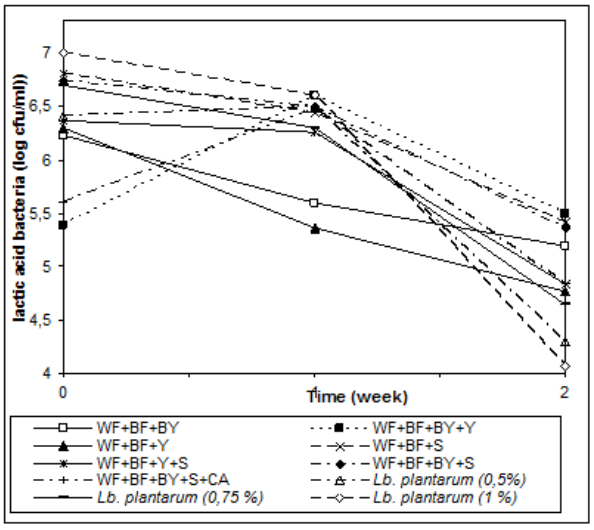

Figure 4. Lactic acid bacteria growth during fermentation**.**

The high numbers of TB slightly decreased from 5.64-8.56 log cfu/ml to 4.56-7.4 log cfu/ml. On the 2nd week, these numbers decreased to minimum 2.86 log cfu/ml. Microbial growth was inhibited by increasing acidity [16]. The decrease in TB numbers through the 2nd week, less growth and even no growth of CB, were desirable (Figure 5).

MY number of 1% *L. plantarum* inoculated samples showed a sharp decrease. At the end of the 2nd week MY didn't grow in *L. plantarum* inoculated and

WF+BF+S added samples. The high lactic acid amount in these samples could have inhibitory effect on MY growth (Figure 6).

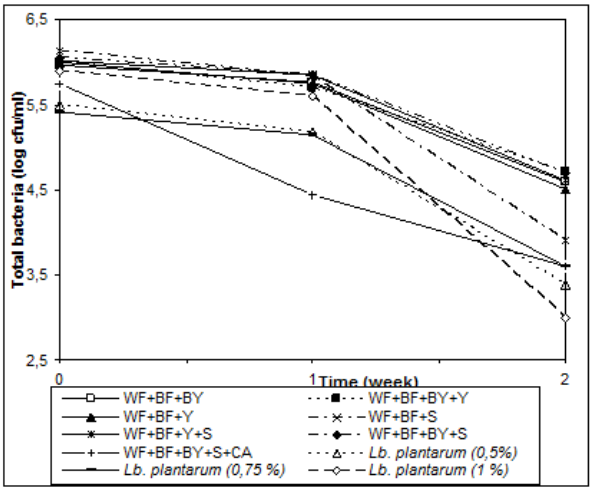

Figure 5. Total bacteria growth during fermentation

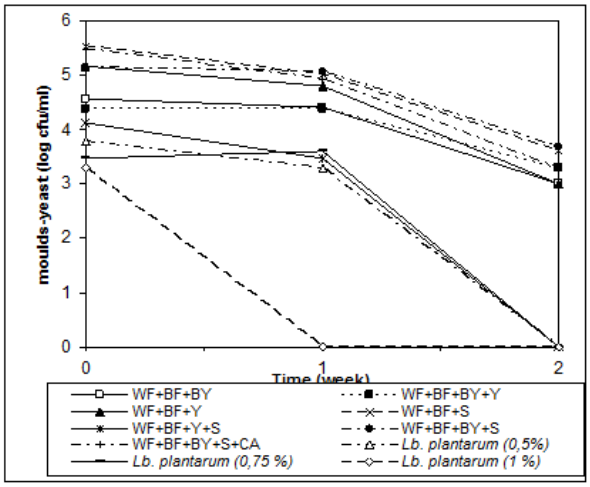

Figure 6. Molds-yeast growth during fermentation

The counts of CB in all samples decreased from 2.16-2.61log cfu/ml to 0-1.78 log cfu/ml in a week. On the 2nd week CB were not detected except 0.30-0.48 log cfu/g in two samples. As black carrot and turnip are the underground roots and due to contamination from soil and other environmental factors CB present in high numbers at the beginning of fermentation (Figure 7).

In a study on another Turkish traditional fermentation beverage, Boza, LAB counts were found about 5.89-6.54 log cfu/ml, in samples prepared with yeast-LAB combinations in the initial of fermentation [17]. Mugula et al. [18] studied on a Tanzanian fermented beverage, togwa, and reported that LAB counts increased to 9 log cfu/ml in 8 h. Erginkaya and Hammes [5] reported that the initial LAB count in Şalgam juice was between 6-7 log cfu/ml. This number increased to 8-9 log cfu/ml in 2 day fermentation. According to Nout et al. [19], desirable low pH values were quickly reached with starter culture inoculation and this may inhibit the growth and toxin production by food-borne enteropathogens.

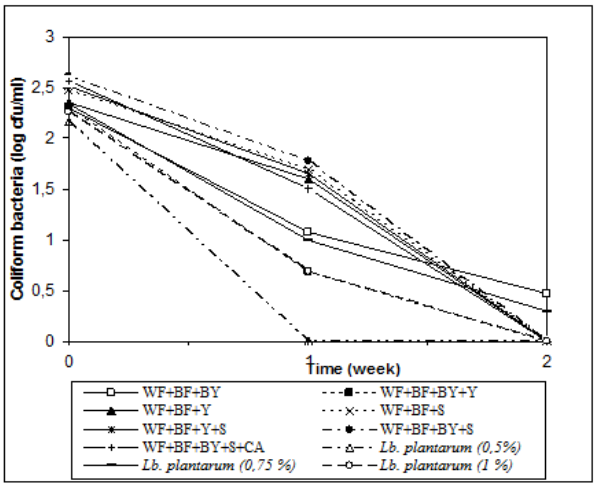

Figure 7. Coliform bacteria growth during fermentation.

Sensory Analysis. The sensory analysis results of Şalgam juice samples are shown in Table 1. For all the tested parameters Şalgam juice inoculated with all concentrations of *Lb. plantarum* and samples fermented by saccharose containing sourdoughs (except citric acid added sourdough) had the best sensorial quality and were more acceptable than the other samples. There was a significant ($p<0.05$) difference between the samples for their color and taste scores. WF+BF+BY and WF+BF+S+CA had the least color scores. Citric acid revealed a light red color which was not preferred near the red-purple colors of other samples. The differences between odor scores were not statistically significant. *L. plantarum* is a heterofermentative lactic acid bacteria species. It was reported that heterolactic LAB isolates are more important than homolactics in producing flavor and aroma components such as acetaldehyde and diacetyl 20. The higher LAB growth in these samples (Figure 6) can be related to their highest sensory scores for odor and taste.

Table 1. Results of sensory analysis*

Sour dough compositions	Color	Odor	Taste
WF+BF+BY	18±2.7^{bc}	19±6.5	11±4.1^{d}
WF+BF+BY+Y	20±0^{ab}	19±2.2	12±2.7^{cd}
WF+BF+Y	21±4.1^{ab}	19±6.5	14.4±3.7^{bcd}
WF+BF+S	23±2.7^{a}	18.6±4.1	22±2.7^{a}
WF+BF+Y+S	23±2.7^{a}	19.4±4.6	12±2.7^{cd}
WF+BF+BY+S	21±4.1^{ab}	21±2.2	23±2.7^{a}
WF+BF+BY+S+CA	14±4.1^{c}	14±2.2	18.6±8.7^{abc}
Lb. plantarum (0.5%)	22±2.7^{ab}	21±4.1	17.6±6^{abcd}
Lb. plantarum (0.75 %)	23±2.7^{a}	19±4.1	21±2.2^{ab}
Lb. plantarum (1 %)	22±2.7^{ab}	20±4.4	24±2.2^{a}

* Category: 5-very poor; 10-poor; 15-normal; 20-good; 25-perfect
** Means with different superscript letters differ significantly (p<0.01)

4. Conclusion

Judging from the decrease in pH, production of lactic acid and high consumer acceptability, *Lb. plantarum* starter cultures could be used to produce Şalgam juice within a week period.

Also, saccharose containing sourdough combinations, except citric acid added one, lead to desirable pH and acidity values along with high sensorial acceptability. But, starter culture inoculation is much more advisable in order to avoid variations in the quality of these type traditional fermented products. Citric acid wasn't found suitable in Şalgam juice production as it left a lighter color to the product. Yoghurt in sourdough didn't appear to be a promising avenue for the lower taste scores which can be associated with low lactic acid formation in these samples.

Acknowledgement. This work was supported by Selçuk University Scientific Research Project (S.U.-BAP, Konya-Turkey).

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Caplice E & Fitzgerald GF, Food fermentations: role of microorganisms in food production and preservation. *Int J Food Microbiol*, **1999**, *50*, 131-149.
2. Canbaş A &Fenercioğlu H, A research on Şalgam juice. *Gıda*, **1984**, *9*(5), 279-286.
3. Hammes WP, *Biotechnology; biochemical engineering and food technology*, ed. Y. Chimiel, Hammes. Bailey; Biochemical engineering. Gustav Fischer Verlag-Stuutgart, New York, 1987, pp. 11-35.
4. Spicher G, Die Sauerteiggaerung. Chemie Microbiologie Techologie. *Chem Microbiol Techol Lebens.*, **1986**, *10*, 65-77.
5. Erginkaya Z &Hammes WP, Şalgam suyu fermentasyonu sırasında mikroorganizmaların gelişimi ve izole edilen laktik asit bakterilerinin tanımlanmaları üzerine bir araştırma. *Gıda,* **1992**, *17*(5), 311-314
6. Deryaoğlu A, Şalgam suyu üretimi ve bileşimi üzerinde bir araştırma. PhD thesis, Çukurova University, Adana, 1990, Turkey.
7. Tanguler H, Utus D & Erten H, Effect of black carrot size usage on the quality of shalgam (Şalgam): A traditional Turkish lactic acidfermented beveragre, *Indian Journal of Traditional Knowledge*, **2014**, *13*, 647-653.
8. Ünal SS, *Cereal Technology*. Ege University Faculty of Engineering Department of Food Science Press, Third edition, No:29, İzmir, 1991, pp.216.
9. Schobinger U, In: *Process Technology of Fruit and Vegetable Juice*, ed. J. Acar. Hacettepe University Press, Ankara, Grafik Press, Ankara, 1992, pp. 602
10. AOAC. *Official Methods of Analysis*, 14th edn. Association of Official Analytical Chemists, Arlington, 1984, VA.
11. Etchells JL & Bell TA, *Pickle products*, ed.M. Speek, In Compendium of Methods for the Microbiological Examination of Foods. Washington: Amer. Public Health Association, 1976, pp. 574-593.
12. Altuğ T, Ova G & Demirağ K, Ü. Kurtcan, Food Quality Control. Ege Univ.ersity Faculty of Engineering Publ. Nu. 29, İzmir, 1995, pp. 157.
13. Özcan M, Pickling caper flower buds. *J. Food Qual.*, **2001**, *24*, 261-269.
14. Türker I, Asit fermentasyonları (Sirke, Turşu, Sofralık zeytin ve Boza Teknolojileri). Ankara University Faculty of Agriculture Publ., no: 557, 1975, Ankara, pp. 182.
15. Özler N & Kılıç O, 1996. Şalgam suyu üretimi üzerinde araştırmalar. *Gıda* , **1996**, *21*(5), 323-330.
16. Özcan M & Akgül A, Storage quality in different brines of pickled capers (*Capparis* spp.). *Grasas y Aceites*, **1999**, *50*(4), 269-274.
17. Zorba M, Hancıoğlu O, Genç M, Karapınar M & Ova G, The use of starter cultures in the fermentation of boza, a traditional Turkish beverage.*Process Biochem.*, **2003**, *38*, 1405-1411.
18. Mugula JK, Narvhus JA & Sorhaug T, Use of starter cultures of lactic acid bacteria and yeasts in the preparation of togwa, a Tanzanian fermented food. *Int J Food Microbiol.*, **2003**, *83*, 307-318.

19. Nout MJR, Rombouts FM & Havelaar A,1989. Effect of natural lactic fermentation of infant food ingredients on some pathogenic microorganisms. *Int J Food Microbiol,* **1989**, *8*, 351-361.

20. Jay JM, *Fermented foods and related products of fermentation*. In: Modern Food Microbiology, 4th ed. New York, London: Chapman and Hall, 1992, pp. 371-409.