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# CHANGES IN PHYSICO-CHEMICAL PARAMETERS, BIOACTIVE COMPOUNDS AND SURVIVAL OF *Lactiplantibacillus plantarum* J12 IN FERMENTED CARROT JUICE

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**ABSTRACT**

Carrots are economically significant vegetables; however, their perishability necessitates their processing into a variety of products, especially juices. Therefore, this research evaluated the fermentation of carrot juice with the probiotic bacterium *Lactiplantibacillus plantarum* J12, as well as the modification of some features under storage. The tested strain showed good growth properties on carrot juice without any other supplementation. The viable cell counts of *L. plantarum* J12 was 4.38 $10^6$ CFU/ml at 0 h and reached 1.93 $10^9$ CFU/ml after 24 h of fermentation (increase of $10^3$ CFU/ml). The fermentation had a partial effect on the physico-chemical parameters of the juice : a slight increase in the electrical conductivity, viscosity and turbidity of the lactofermented juice compared to the control was observed. Furthermore, lower sugar content with a good reduction in glucose was noticed. Phenolic and flavonoid compounds were higher in the control juice, but the antioxidant activity was better in the fermented juice. The sensory evaluation showed good acceptance with a better score attributed to the lactofermented juice. Cold storage for 21 days showed good strain survival, as well as pH and acidity stability. The results suggest that the probiotic *L. plantarum* J12 can be applied to produce functional juice for lactose-intolerant individuals and vegan population.

## 1.Introduction

The change in eating habits is the result of a rapid socio-cultural evolution; consumers are more concerned about their diet. Thanks to progress in the agri-food industry, food production has no longer the only purpose of satisfying basic needs, but of searching something more to add for health and to be able to compete with new products. Processed foods represent a growing part of the market, among these are functional foods. The latter, attract the attention of consumers because they are associated with the prevention or treatment of several illnesses comprising hypertension, diabetes, and cancer (Topolska et al., 2021).

Carrots and carrot juice are among those trending foods that have caught the attention of several researchers (Adiamo et al., 2018; Hu et al., 2019; Malik et al., 2019; Wuyts et al., 2018; Zhang et al., 2019). Due to its richness in carotenoids (mostly β-carotene), trace elements (iron, zinc, manganese, calcium, phosphorus and molybdenum), polyphenols (Martínez-Flores et al., 2015), and to its various biological activities (antioxidant, hypoglycemic activities, eyesight protection, anti-aging and immunity improvement) (Malik et al., 2019), carrot juice represents a very good solution to transform this perishable vegetable, which allows limiting major losses for farmers, and valorizing downgraded carrots which cannot be destined to the market because of their size (Rafiq et al., 2016).

Existing food probioticification is one of the strategies utilized to develop new functional foods. Several microorganisms, mostly lactic acid bacteria (LAB), may provide this probiotification (Zhang et al., 2019). The ability of these microorganisms to enhance the nutritional, hygienic, and sensory properties of fermented foods, as well as to give therapeutic benefits such as the reduction of type 2 diabetes, has received interest (Hu et al., 2019). Generally, LAB are carried by dairy products, but as there are many people who do not consume these products either for lack of interest or for health reasons such as lactose intolerance, carrot juice is therefore a good alternative to convey probiotic bacteria within this class of the population (Rafiq et al., 2016).

The interest of functional foods had to be scientifically proven; this is why we tried through this work to evaluate the combined effect of *L. plantarum* J12 and the carrot juice by physicochemical analyzes and testing the antioxidant activity of this probiotic juice, as well as carrying out a sensory evaluation to ensure its taste, which will allow us to formulate a functional juice.

## 2. Materials and methods

### 2.1. Materials

#### *2.2.1. Bacterial strain and inoculum preparation*

*L. plantarum* J12 was isolated from chicken's crop at the Laboratory of Biotechnology, Environment and Health, University of Jijel, Algeria. The strain was identified by the 16S rDNA technique. The gene sequence (1406 bp) was determined and deposited at the GenBank database under the accession number KJ690574.

To make the inoculum, a *L. plantarum* J12 glycerol stock culture tube was put to a 250 ml beaker with 100 ml MRS broth. Cultures were grown at 37 °C until their cell density attained 0.600, as measured spectrophotometrically (OD590), which corresponds to 9.00 Log CFU/ml on the MacFarland scale. After centrifugation at 5000 x g for 5 minutes, the cells were collected. For starting inoculation, the cell pellets were recovered, rinsed, and resuspended in peptoned water (0.1%).

#### *2.2.2. Juice preparation*

Local carrots (Daucus carota L) were acquired from a market (Jijel, Algeria). The carrots were properly rinsed with distilled water, scraped, and divided into about 3.5 cm by 0.5 cm by 0.5 mm in thickness pieces. In the next step, the fragments of carrots were blanched in distilled water with 3 g/l of citric acid for 3 minutes at 90 °C. Then, they were grinded (Zhao et al., 2014). Finally, a centrifugation at 4000 g for 5 min was performed to separate the juice from the pulp. The juice was filled in glass bottles and pasteurized at 70 °C for 2 min. The contents of the flask were split into two groups, one as a control and the other was inoculated with 5% v/v by the *L. plantarum* J12 culture (final concentration approximately $10^6$ CFU/ml). After that, the fermentation process was carried out at 37 °C for 24 h (Tamminen et al., 2013). After fermentation, the flasks were kept at 4 °C for 03 weeks.

### 2.2. Methods

Various parameters were investigated to elucidate the effect of fermentation immediately after recuperation of flasks (physical parameters, content of bioactive compounds). To investigate the effect of conservation, samples were analyzed every 3 days during 3 weeks (bacterial counts, pH and acidity measurements). Sensory evaluation was performed 24 h after the end of fermentation.

#### *2.2.1. Viable cells count*

*L. plantarum* J12 was cultured on MRS agar to determine its viability (Difco Laboratories, Sparks, MD). Plates were then incubated 24 h hours at 37 °C (Malik et al., 2019).

#### *2.2.2. pH and titratable acidity determination*

After calibrating a pH meter (Model Hanna pH 211, USA), the pH of carrot juice samples was measured by immersing an electrode directly into 50 ml of juice at 20 °C (Zhang et al., 2016).

Titratable acidity (TA) was measured through titration with 0.1 N NaOH solution in the presence of phenolphthalein (Daneshi et al., 2013). TA was based on lactic acid percentage.

### *2.2.3. Total soluble solids assay, protein and ash determination*

A refractometer was used to determine the total soluble solids (TSS) in Brix degree (Model Atago HSR-500, Japan) at room temperature (Jin et al., 2019). The Kjeldahl technique was used for proteins determination. The ash was measured after incineration of 1 g of the juice in the muffle furnace at 550 °C.

### *2.2.4. Measurement of electrical conductivity*

The electrical conductivity of the juice was evaluated by immersing the electrode of the conductivity meter (Bioblock, Belgium) in a beaker containing 30 ml of sample; the reading was done directly on the display of the conductivity meter at 23 °C.

### *2.2.5. Turbidity*

A portable Turbidimeter (Aqualytic SN 084591, Germany) was used to determine the turbidity of the juice. Results were expressed in nephelometric turbidity units (NTU).

### *2.2.6. Viscosity*

The viscosity was measured with an AR 1000 rotary viscometer (Haake, Viscotester, Germany) equipped with a cone (angle 2°, diameter 40 mm) and a spindle (spindle R1, 20 x g). Its container was filled with 250 ml of sample and then the probe was introduced into the container by changing the scale of measurement until the exact viscosity value was obtained on the screen of the apparatus. The viscosity value was expressed in mPa/s.

### *2.2.7. Determination of sugar content*

Five ml of carrot juice samples were homogenized and filtered through 0.45 µm cellulose acetate membrane (VWR, Mississauga, ON, Canada). Using an HPLC system (Knauer Co., Ltd, Germany), the filtrate was utilized to evaluate the concentration of sucrose, fructose, and glucose in carrot juice samples. The mobile phase comprised of water: acetonitrile (75:25, v/v) and a column of (4.6 / 250 mm) was utilized. External standards with sucrose, glucose and fructose HPLC grade were used for quantification, the findings were reported in terms of grams per liter of carrot juice (Zhang et al., 2016).

### *2.2.8. Extraction of phenolic compounds*

One milliliter of carrot juice was used to extract phenolic compounds, with 10 ml of methanol in dark and agitation in an orbital shaker for 24 h (Infors AG CH-4103 Bottmingen, Switzerland). Supernatants were collected after centrifugation at 5000 x g for 5 min (Sigma, Germany) and stored at 4 °C (Martínez-Flores et al., 2015).

### *2.2.9. Total phenolic compounds (TPC)*

200 µl of the extracted solution was combined with 4.0 ml of distilled water and 400 µl of Folin-Ciocalteau reagent with a Vortex (MS2 Mini shaker, VWR) and maintained at room temperature (25 °C ± 1 °C) for 10 min. Next, 1.25µl of 20% Na2CO3 solution was added, stirred, and maintained for 120 min in the dark. Using a spectrophotometer (Model Ultrospec 100 pro Shimadzu, Germany) at 760 nm, the absorbance was read. The findings were represented in µg of gallic acid equivalents per milliliter of sample (µg GAE /ml) (Adiamo et al., 2018).

### *2.2.10. Total flavonoids contents (TFC)*

After adding 1 ml of each sample of extract to 1 ml of $AlCl_3$ solution and letting it sit for 10 min at room temperature, the OD was taken at 415 nm. The concentration of flavonoids was deduced from a calibration curve established with quercetin and expressed in equivalent µg of quercetin per ml of sample (Talbi et al., 2015).

### *2.2.11. Total Carotenoids*

The total carotenoids were analyzed using the methodology given by Martnez-Flores et al (2015). Two ml of carrot juice and ten ml of chloroform/methanol (2:1, v/v) were stirred for 5 min. After shaking, the organic and aqueous phases were separated, and the latter was filtered

and recovered using filter paper. The operation was repeated four times with the aqueous phase using 5 ml chloroform/methanol. The extracts were then combined and diluted using chloroform/methanol to a maximum volume of 50 ml. Carotenoids were quantified at room temperature, at an absorbance of 450 nm, using a spectrophotometer (Model Specord 50 plus, Analytic jena, Germany). Standard solutions of β-carotene were used at different concentrations (2–10 µg/ml). Results were expressed as µg β-carotene equivalent per ml of carrot juice.

### *2.2.12. Antioxidant capacity*

The antioxidant capacity was determined using the method published by Kourouma et al (2019). 2.5 mg of DPPH was dissolved in 100 ml of methanol to create a stock solution (0.0625 mmol/L) that was stored in the dark at room temperature. Then, 200 µl of carrot juice was combined for 30 min in the dark with 3 ml of DPPH solution. Using a spectrophotometer (Model Specord 50 plus, Analytic jena, Germany) and methanol as a blank, the absorbance was measured at 517 nm. According to the following equations, radical scavenging ability (RSA) was expressed in terms of the percentage of DPPH inhibition:

$$DPPH\ RSA\ (\%) = [(A_0 - \mathrm{As})/A_0] \times 100 \quad (1)$$

where $A_0$ was the absorbance of DPPH radical solution without sample and As was the absorbance of the sample.

### *2.2.13. Sensory evaluation*

The sensory assessment was conducted using Zhang et al approach's (2016). An untrained panel of students (9 male, 9 female) aged between 19 and 28 years at the University of Jijel were volunteered to take part in this study. To be considered, panelists had to be non-smokers and not allergic to carrots. A randomized block was designed to determine carrot juice order. Each carrot juice was drunk by every volunteer independently of the others. A questionnaire was used to measure the preference of each carrot juice's taste, color, appearance, aroma and overall acceptability on a 9-point hedonic scale with a degree of liking where 1 = dislike extremely and 9 = like extremely. The subjects were given carrot juice samples in little plastic cups, and they were allowed to note their responses on the reverse of the questionnaire.

### *2.2.14. Statistical analysis*

Tests were conducted in triplicate, and findings were presented as mean ± SD. Differences between samples were calculated by analysis of variance (ANOVA) using SPSS software version 16 (SPSS Inc., Chicago, IL, USA). A p-value < 0.05 was assigned statistical significance.

## 3. Results and discussions

### 3.1. Lactofermentation process

As displayed in Table 1, supplementation of *L. plantarum* J12 to carrot juice causes a little change in the juice's approximate composition. Comparable to the control sample (CJ), lactofermented juice (LJ) had a considerably decreased moisture content which went from 93.78% to92.86%. The opposite was noticed with the protein and ash content that have increased from 0.46% and 0.16% to 0.74% and 0.24% respectively. Furthermore, sugar contents were significantly lower than in CJ ($P < 0.05$). These modifications may be the result of the probiotic's action and the production of metabolites. Our findings are consistent with those of Rafiq et al (2016), who formulated a probiotic carrot juice with *L. acidophillus*, *L. plantarum*, *L. casei* and *Bifidum longum*. However, their results were slightly higher than ours.

The carrot juice was inoculated with *L. plantarum* J12, at an initial cell density of about $10^6$ CFU/ml. *L. plantarum* J21 was found to be capable of growing well on pasteurized carrot juice without any nutrient supplementation. Zhang et al. (2019) has reported that *L. plantarum* WZ-01 strain could proliferate rapidly in native carrot juice.

**Table 1.** Effect of lactofermentation by *L. plantarum* J12 on physicochemical parameters, bioactive compounds and antioxidant activity of carrot juice.

| | | Control juice | Lactofermented juice |
|---|---|---|---|
| **Moisture** (%) | | 93.78 ± 1.24 | 92.86 ± 2.33 |
| **Protein** (%) | | 0.46 ± 0.23 | 0.74 ± 0.17 |
| **Ash** (%) | | 0.16 ± 0.4 | 0.27 ± 0.06 |
| **Sugars** *(g/l)* | **Sucrose** | 2.722 ± 0.13 | 2.570 ± 0.17 |
| | **Glucose** | 4.031 ± 0.15 | 1.599 ± 0.19 |
| | **Fructose** | 3.657 ± 0.16 | 3.359 ± 0.11 |
| **TSS** ***(°Brix)*** | | 7.8 ± 0.1 | 7.1 ± 0.2 |
| **Bioactive compounds** | **TPC** *(µg GAE/ml)* | 296.58 ± 4.05 | 211.47 ± 2.87 |
| | **TFC** *(µgRE/ml)* | 79.21 ± 3.24 | 57.43 ± 2.82 |
| | **Carotenoids** *(µg/ml)* | 1.05 ± 0.03 | 0.98 ± 0.08 |
| | **DPPH** (%) | 51.7 ± 5.78 | 62.6 ± 6.46 |
| **Physical parameters** | **Viscosity** *(mPa/s)* | 1.36 ± 0.09 | 1.46 ± 0.04 |
| | **Turbidity** *(NTU)* | 2655 ± 122 | 2990 ± 156 |
| | **Conductivity** | 0.436 ± 0.06 | 0.523 ± 0.08 |

The growth of *L. plantarum* requires the minerals $Mg^{2+}$ and $Mn^{2+}$. A good quantity of carbohydrates, magnesium, phosphorus, calcium, iron, potassium, sulphur, manganese, and copper can be found in carrots (Rafiq et al., 2016). Therefore, carrot juice may serve as a substrate for probiotic bacteria like lactic acid bacteria (Malik et al., 2019). *L. plantarum* is an auxotrophic bacterium. it starts to use carbohydrates (mainly glucose) present in the juice, then it will attack proteins. moreover, it is able to convert some amino acids into others, such as the conversion of methionine into cysteine, which allows it to survive in the carrot juice (Wegkamp et al., 2010).

During 24 h of fermentation in carrot juice, the growth of *L. plantarum* J21 increased logarithmically from an initial population of $4.90\times10^6$ CFU/ ml to reach $1.93\times10^9$ CFU/ml (Figure 1). Our results were in agreement with those reported by Wuyts et al. (2018) when they checked microbial community dynamics using high-throughput sequencing of 16S rRNA gene of 38 household carrot juice fermentations, where the number reached $3.37\times10^9$ CFU/ml after 3 days of fermentation. Zhang et al. (2019) prepared a lactofermented carrot juice with *L. plantarum* WZ-01, and they obtained a cell density of about $5.3\times10^8$ CFU/ml in 48 h. Data given by Nguyen et al. (2019) showed that the cell count of *L. plantarum* 299V was significantly higher in comparison of that of the *L. acidophilus* La5 strain where both strains were used in the fermentation of pineapple juice. According to these authors, the origin of the strain plays an important role in its adaptation to the fermentation substrate. A strain isolated from a plant source grows better than one isolated from an animal source. Despite this, our strain has been adapted very well to the carrot juice.

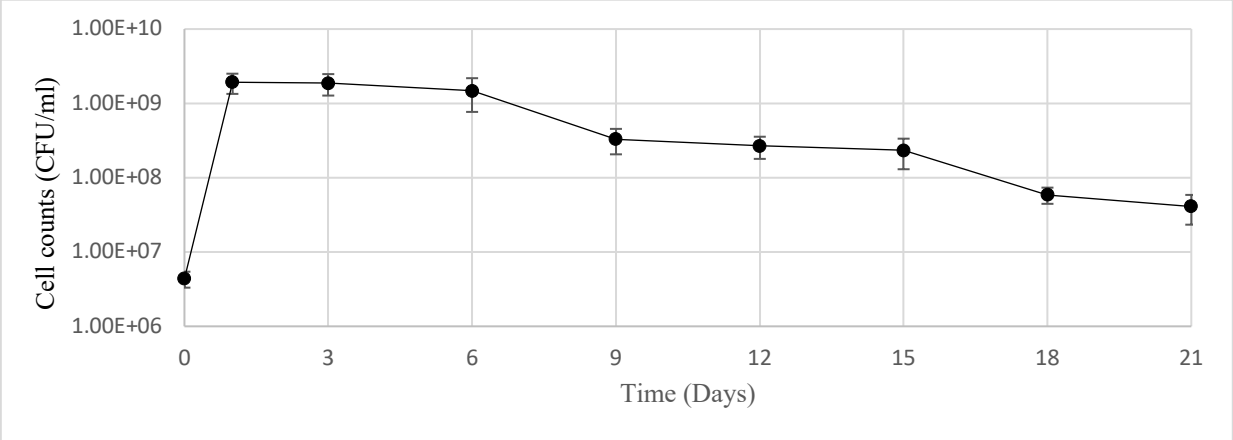


**Figure 1.** Fermentation process and survival of the strain *L. plantarum* J12 during storage at 4 °C

### 3.2. Effects on the physicochemical parameters of the juice

Physical parameters, bioactive compounds, and contents of some sugars after 24 h of fermentation are summarized in Table1**.** It had been reported that *Lactiplantibacillus* have high requirements of fermentable carbohydrates, vitamins, free amino acids and peptides for growth (Śliżewska and Chlebicz-Wójcik, 2020). Interestingly, our carrot juice was rich in fermentable sugars.

The pH of the produced carrot juice before fermentation was about 5.45; then after the fermentation process, the pH dropped to 4.10 at 24 h. The pH of the CJ, which is placed under the same conditions, remained almost unchanged, with a value of 5.41 (Figure 2). On the other hand, the acidity increased considerably during the fermentation and reached 0.69. Lactic acid is the main acid produced by *L. plantarum*, although other acids can be also produced because of hydrolysis and microbial activity (Jin et al., 2019). The concentration of these acids increases as the biomass increases which leads to a considerable drop in pH. Similar results for pH decrease were reported by Demir et al. (2006) when they studied the properties of carrot juice inoculated by *L. plantarum* at different concentrations. The increase of acidity was reported by Malik et al. (2019) in carrot juice substrate fermented with *L. plantarum* which increased from 0.15% to 0.88% during 72h.The main function of *L. plantarum* is the conversion of sugar to lactic acid, which explains the drop in pH and the sugar content during fermentation. Indeed, the concentration of sucrose, glucose and fructose at the CJ were 2.722, 4.031 and 3.657 g/l, then they passed to 2.570, 1.599 and 3.359 g/l, respectively at the end of the fermentation (Table 1). Some works reported that many LAB strains, especially *L. plantarum* are natively able to utilize simple sugars (Garcia et al., 2020; Wuyts et al., 2018). The order of utilization of sugars by *L. plantarum* J12 was glucose>sucrose>fructose. Nguyen et al. (2019) gave an order of fructose > glucose ≥ sucrose with pineapple juice fermented by *Lactiplantibacillus* and *Bifidobacterium* strains. After 24 h of fermentation, the TSS of LJ decreased from 7.8 to 7.1 °Bx (Table 1). This result agree with those of Do and Fan (2019).

Electrical conductivity is an important parameter for evaluating the quality of any juice; it gives an idea on the freshness of the product. It is low when the juice is fresh and increases when it loses its freshness. It also makes possible to detect changes in the structure of the treated product. The obtained results show that the conductivity of the LJ is 0.523 ± 0.08; it was a little higher than that of the CJ which was 0.436 ± 0.06, but this difference is not significant statistically ($P > 0.05$). These values are similar to those found by Rodrigo et al. (2003) who reported conductivities of 0.416 ± 0.11, 0.375 ± 0.01 and 0.435 ± 0.03 in three types of orange-carrot juice mixtures stored at different temperatures.

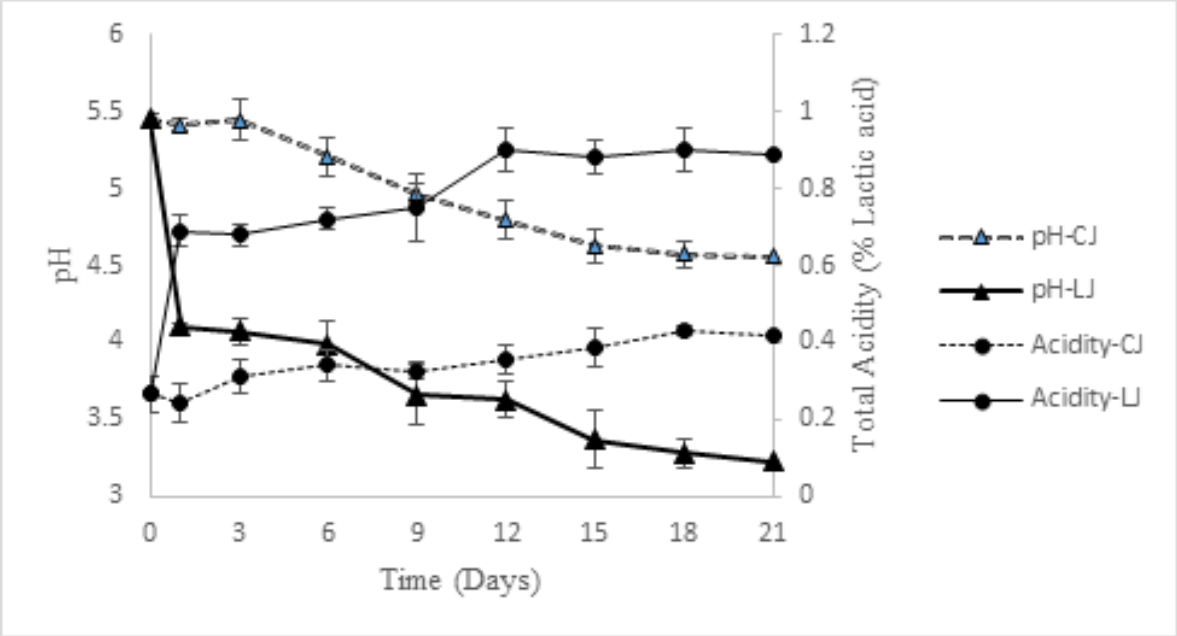


**Figure 2.** Variations in pH and acidity of CJ and LJ during storage at 4 °C

Electrical conductivity is influenced by the pH of the solution, the valence of the ions and the degree of ionization. This small improvement in electrical conductivity might be related to mineral components or vitamins released from carrot tissues throughout fermentation.

Viscosity represents the resistance to flow and movement of a liquid. Statistical analysis showed a non-significant difference ($P > 0.05$) between the values of juice samples. However, we notice that the viscosity of LJ (1.46 ± 0.04) is a little higher than that of CJ (1.36 ± 0.09). These results are lower than those found by Martínez-Flores et al. (2015). This partial rise in viscosity may be attributed to an increase in the solvation of pectin in cell wall membranes (Xiang et al., 2014).

Bottom sediment formation in carrot juice is a cloud stability problem, but it do not affect the visible loss of turbidity (Reiter et al., 2003). As shown in Table 1, the turbidity of the carrot juice was increased after fermentation, it changed from 2655 NTU to 2990 NTU, but statistically there is no significant difference ($P > 0.05$). This increase in turbidity could be explained by an increase in the number of particles related to degradation of substrates contained in the juice such as pectins, these particles are too small to affect the particle size distribution (Chen et al., 2019). Nevertheless, the turbidity values of our juices are lower than those given by other authors (Reiter et al., 2003; Yu and Rupasinghe, 2012).

### 3.3. Changes in bioactive components and antioxidant activity

Phenolic compounds are among the most important phytochemicals that can usually be found in foods of plant origin. As shown in Table1, CJ showed the highest TPC of 296 µg GAE/ml, which was lower than that reported by Zhang et al. (2016) in raw carrot juice. Perla et al. (2012) have reported that phenolic content decreased after pasteurisation because of thermal degradation. After fermentation, a decrease in the TPC value was noticed in LJ sample, which declined to 211 µg GAE/ml. Ciniviz and Yildiz (2020) have concluded that fermentation decreases total phenolics. TFC in LJ dropped from 79.2 to 57.4 µg/ml (Table 1), which is equivalent to a reduction yield of 27.52%. These results were also proven by Malik et al. (2019) who reported that TFC of carrot juice decreased during fermentation with *L. plantarum*, *L. acidophilus*, and *L. casei*. Furthermore, the decreased TPC and TFC did not affect the enhanced antioxidant activity of fermented carrot juice. Li et al. (2019) explained this finding by the fact that supplementation

with LAB leads to the production of certain metabolites with higher antioxidant activity during the fermentation process.

Carotenoids are the major natural pigments that give carrots their color characteristic and have too powerful biological functions. Since human can not produce carotenoids, they have to be provided to him mainly by fruits and vegetables or their juices. Carotenoids in LJ were not degraded by *L. plantarum* J12. The results were unchanged after fermentation. Zhang et al. (2019) obtained similar results after fermentation of carrot juice with *L. plantarum* WZ-01.

Carrots are rich in antioxidants; however, during the transformation of carrots into juice, a significant part of this antioxidant activity is destroyed by technological processes, so it must be recovered by other sources. Fermentation with probiotic and/or LAB remains an effective means because these bacteria produce various metabolites such as antioxidant exo-polysaccharides, superoxide dismutase and glutathione (Tang et al., 2017; Zhang et al., 2019). Table 1 showed the antioxidant capacity of carrot juice determined by DPPH assay. Scavenging activity of DPPH had been enhanced from 51.7% to 62.6% during the fermentation of carrot juice by *L. plantarum* J12. Various studies reported that *L. plantarum* enhance antioxidant activity in carrot juice (Zhang et al., 2019), pineapple juice (Nguyen et al., 2019), beet roof juice (Malik et al., 2019) and apple juice (Li et al., 2019).

### 3.4. Sensory evaluation

The sensory assessment of a juice has a significant impact on customer acceptability and preference. The sensory evaluation of both CJ and LJ was performed 24h after the end of the fermentation process. The sensory score (Figure 3) increased during fermentation, indicating that *L. plantarum* J12 could improve the sensory attributes of the carrot juice. The scores of overall acceptability, flavor and acidity increased from 6.42, 3.78 and 5.14 to 7.14, 4.92 and 6.35, respectively. There were no visible color or appearance variations amongst the samples. Several authors (Malik et al., 2019; Tamminen et al., 2013; Zhang et al., 2019) have showed that carrot juice fermentation by lactic acid bacteria improves its sensory qualities. In addition, fermentation reduces the sugar content and the produced acids give a refreshing taste.

### 3.5. Survival of *L. plantarum* during storage

The international standards describe that for health and functional point of view, the probiotic products should contain at least of $10^6$ viable bacterial cells per gram of product at the moment of consumption (Daneshi et al., 2013). The storage of the carrot beverage was carried out with and without supplementation. Viable counts (log CFU/ml) of our strain in carrot juice during storage at 4 °C over 21 days are presented in Figure 1. The microbial population did not change significantly in this period. For all storage period, strains reached a viable cell number reduction of less than 2 log CFU/ml and remained greater than 7 log CFU/ml. The cell viability depends on various factors such as final acidity of the product, the used strain, the concentration of lactic acid and acetic acid, oxygen content and interaction between existing species.

During refrigerated storage (4 ºC), the pH of the CJ did not show significant change (Figure 2) in the first six days but it was decreased to 4.55 after 21 days. Moreover, there is a large drop in pH of the LJ after the fermentation process (from 5.42 to 4.09), then a gradual drop during refrigeration. At the same time, the acidity of the two juices increased slightly during storage, with the exception of the brutal increase noted in the LJ during fermentation. Nualkaekul and Charalampopoulos (2011) reported similar results in fruit juices lacto-fermented by *L. plantarum* and stored under refrigeration for 6 weeks.

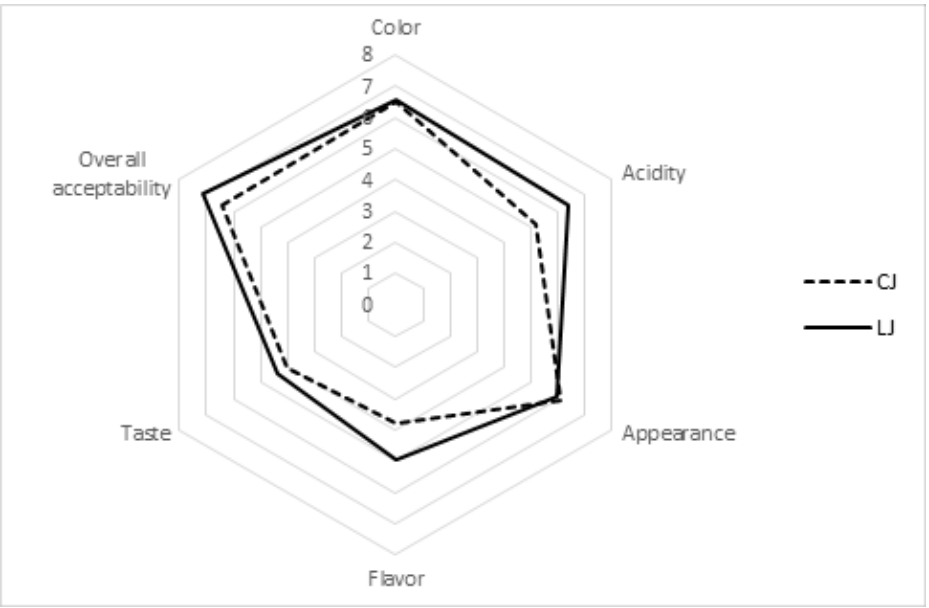


**Figure 3.** Sensory analysis profile of CJ and LJ

## 4. Conclusions

The present study confirms that the strain *L. plantarum* J12 proliferates well in carrot juice and can survive during storage at 4 ºC. Viability was satisfactory with less than a two log CFU/ml decline. Furthermore, it was noticed that TPC and TFC reduced in the fermented carrot juice. At the end of the fermentation, the antioxidant capacity had risen. The lacto-fermented juice had a better acceptability from the tasting panel. It may be established that *L. plantarum* J12 has a promising use in the fermentation of carrot juice., which can be a functional drink especially for people who do not consume dairy products. Further studies, *in vivo*, concerning the beneficial effects of this strain should be carried out.

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