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CHARACTERIZATION OF TOMATO SAUCE ENRICHED WITH PURSLANE (*PORTULACA OLERACEA*) LEAVES

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Abstract

The recent investigations have shown that we assist at a distorted intake of polyunsaturated fatty acids. This problem is considered one of the harmful aspects of daily diet. In this context the development of functional food enriched with omega 3 compound must be considered. Purslane was considered a proper omega-3 fatty acids source because it leafy contains the highest polyunsaturated fatty acids amount than any other vegetable. In this study the effects of fresh purslane leaves on the physico-chemical characteristics of tomato sauce was investigated.

The tomato sauces enriched with different fresh purslane leaves concentrations (in the range 1 - 10%, w/w) were subjected to one month monitoring and the specific parameters were measured (apparent viscosity, color, moisture, pH, total acidity, total soluble solids, ascorbic acid, and a_w). For the analysis of followed parameters specific equipment was used: the ViscoMeter DV-I Prime, the colorimeter Chroma Meter CR-400, the moisture analyzer - WPS 110 S, the water activity meter - Aqualab Lite, the pH meter HQ11d and a refractometer N 20E. The ascorbic acid concentration was determinate using a High Performance Liquid Chromatography (HPLC) Shmadzu system coupled with Ultraviolet - visible (UV–Vis) detector.

The addition of purslane to tomato sauce did not affect qualitatively the rheological properties of the sauce while addition of the leaves showed significant qualitative and quantitative differences. Moisture, total soluble solids, pH and total acidity values increased with increasing leaves content.

These results indicate that the application of purslane leaves in tomato-based food products would be desirable and beneficial.

***Key words**: Balancing the omega amount, Fresh weed leaves, Improving sauces.*

1. Introduction

Fatty acids are essential parts of any healthy diet and critical for many bodily functions. The fats in our diets support neurological health, hormone production and reproduction, balance cholesterol levels and aid in satiety and control our appetites etc. (Forouhi *et al.*, [1]). From foods human body receives two main types of fatty acids: saturated fats and unsaturated fats. Unsaturated fatty acids include the types called monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). Omega-3 and omega-6 fatty acids are PUFAS, while omega-9s are MUFAS (Weisenberger, [2]).

Traditional food habits of different populations maintain highly unsaturated fatty acids balances that range from 25% to 85% Omega-6 in highly unsaturated fatty acids and associate with the incidence and severity of many different chronic disorders made worse by omega-6 eicosanoids (Clark and Lands, [3]). To avoid health problems, our diet must respect a certain balance between the two series of essential fatty acids. The ratio between omega 3 and omega 6 should be 1: 1, 1: 2, maximum 1: 4, that is, a portion of essential omega 3 fatty acid to a maximum of four parts of omega-6 fatty acids.

Nowadays there is no balance at all, so it was found ratios of 1 : 22, 1 : 24 between omega 3 and omega 6. Our diet contains many saturated fats (taken from meat and dairy products) and omega 6 fatty acids (taken from vegetable oils) but it is very poor in omega 3 fatty acids (fish) (Mencinicopschi, [4]). Also, due to agribusiness and modern agriculture human diets contain excessive levels of omega-6 PUFAs, but very low levels of omega-3 PUFAs, leading to an unhealthy omega-6/omega-3 ratio of 20 : 1, instead of 1 : 1 that was during evolution in humans (Simopoulos, [5]). The combined impact of multiple food choices creates highly unsaturated fatty acids imbalances for population around the world. New food choices with more positive Omega 3 - 6 balance scores can reverse imbalances.

Consumers need new functional foods and nutraceuticals to help them avoid the need to medicate preventable health conditions and to maintain better a quality of life.

For example, pizza is a favourite food for many of us. The calories and nutritional values of this type of food can vary substantially based on the toppings, the cooking method, the crust and the size of the pizza slice. Choosing veggie toppings like green peppers, tomatoes, and onions will add diet-friendly fibre and antioxidants while cutting calories. The Omega 3 – 6 balance in pizza varies between 1 : 8 to 1 : 15 based on pizza type (USDA, [6]).

A solution to equilibrate the balance is to use additional ingredients containing Omega 3 in the most recommended topping such us the tomatoes. For this we choose purslane, a widely grown in many regions as a staple leafy vegetable with soft, succulent leaves representing also a very good source of alpha-linolenic acid (ALA) and gamma-linolenic acid (LNA, 18:3 w3) (4 mg/g fresh weight) (Uddin *et al.*, [7]). Its fresh leaves contain more Omega-3 fatty than any other leafy vegetable plant any green leafy vegetable (100 grams of fresh purslane leaves provide about 350 mg of α-linolenic acid) (Rudrappa, [8]).

In this study the effects of fresh purslane leaves on the physico-chemical characteristics of tomato sauce was investigated.

2. Materials and Methods

In this study a tomato sauce for pizza was prepared using a simple, home-made receipt. In order to investigate the effects of purslane on the physico-chemical characteristics of tomato sauce the fresh leaves were added in different amounts. The tomato sauces enriched with different fresh purslane leaves concentrations (in the range 1 - 10%, w/w) were subjected to one month monitoring and specific parameters were measured (colour, moisture, protein, total acidity, total soluble solids, pH, a_w and apparent viscosity).

2.1 Sample collection

Fresh sauces ingredients (tomato, basil) were purchased from a local market of Suceava, Romania. *Portulaca oleracea* seeds were provided from Seeds and Garden Plants in Romania. Purslane was growth in laboratory condition, using vegetables ground from a local provider, during three months. Fresh leaves were collected and use for sauces preparation.

2.2 Sauce preparation

The tomatoes were peeled, minced and then boiled with a small amount of salt and oil. Basil was added when the sauce halved its volume. The sauce was divided into five equal amounts and purslane was added in different quantities in four samples (1 g/100 g, 2 g/100 g, 5 g/100 g and 10 g/100 g). The sauces were boiled until the desired consistency was obtained. Hot sauce was divided in four recipients that were sterilized, left for cool to room temperature and stored in fridge at 4 °C until analysis.

2.3 Sauce characterisation

2.3.1 Sauces colour

It has been evaluated using a Konica CR 400 Chroma Meter (Konica Minolta, Japan) and the results were expressed as L (darkness/whiteness), a (greenness/redness), and b (yellowness/blueness) on the Hunter scale (Prisacaru and Oroian, [9]). The instrument was standardised against a white tile (L = 97.30, a = -5.57, and b = 9.08) before each measurement. Each colour value was obtained as the mean of three measurements. The total colour difference (TCD) and colour intensity (C) was calculated using equations 1 and 2 respectively:

$$C = (a)^{0.5} + (b)^{0.5} \quad (1)$$

$$TCD = \sqrt{(L_0 - L_i)^2 + (a_0 - a_i)^2 + (b_0 - b_i)^2} \quad (2)$$

Where: L_0, a_0 and b_0 are the colour values for the sauces without purslane (Şahin-Nadeem *et al.*, [10]).

2.3.2 Total soluble solids (TSS)

TSS were determined according to refractometric method for semiliquid sample using the N 20E Refractometer (SR ISO 2173:2008, [11]).

2.3.3 Moisture

Moisture content was analysed by oven drying process at the temperature 103 °C according to European Standard EN ISO 665/2000, [12], and by using Moisture Analyzer - WPS 110 S.

2.3.4 Total ash

Total ash composition was obtained by calcinations in the furnace (SR ISO 763:2008, [13]).

2.3.5 Protein content

Protein content of tomato sauce has been determined on the basis of total nitrogen content using Kjeldahl method. The average nitrogen (N) content of proteins was calculated by converting the determinate nitrogen content into protein content using the 6.25 factor (SR EN 12135:2005, [14]).

2.3.6 Total acids

They were determined by the titrimetric method using 0.1 n NaOH solution in the presence of 1% solution of phenolphthalein indicator (SR ISO 750:2008, [15]).

2.3.7 pH

Tomato sauce pH was determinate using the pH-METER HQ11d.

2.3.8 Water activity (a_w)

a_w was measured using Water Activity Meter - Aqualab Lite (Ropciuc *et al.* [16]).

2.3.9 Rheological characterization

It was performed with a MARS-Controlled Stress Rheometer (Haake, Germany) using a coaxial geometry of the cylinder to characterize the sauces. Flow curve tests were run through a step shear ramp determined in controlled voltage mode (0.01 - 1 Pa). All rheology measurements were performed after a 0, 2, and 4 weeks' preservation time to monitor the effect of time on tomato sauce.

The determinations were conducted at 8 ^{0}C ± 0.1 using a Phoenix C5P pump (Thermo-Scientific, USA) for temperature control of the sample. The balancing time before rheological tests was 180 s. All measurements were made in triplicate for each emulsion. The results represent the average of three measurements.

3. Results and Discussion

The sauce colour was measured in the sense of lightness (L), red-green axis (a) and yellow-blue axis (b) (Table 1). The values were used to evaluate the total colour difference (TCD) of the samples without purslane in comparison with sauce with different purslane concentration (Figure 1) and the colour intensity (C) (Table 1).

In the case of a, the samples are situated in the positive region (more towards red), as tomato were ripped and the lycopene quantity dominate considerable comparing to chlorophyll when the vegetable are green, all the b samples are situated in the positive region (more towards blue). The colour intensity is higher for sample with purslane: the higher its concentration, the C value increases. Also, as the longer is the sample preservation time the C value is higher (7.5 - 8.16). Total colour difference (TCD) increased with increasing purslane concentration, and the values range between with 1.57 and 2.5, representing a 60% increase when the purslane concentration varied from 1g/100 g to 10 g/100 g. With regard to sample preservation time, the TCD decreases with increasing conservation time (~0.5 unit).

Table 2 shows the mean values of total soluble substances (%), moisture (%), ash (%) and protein (%) content for tomato sauces with 1 g/100 g, 2 g/100 g, 5 g/100 g, and 10 g/100 g purslane (S_1, S_2, S_3 and S_4, respectively) in comparison with the sample without purslane (S_0). The decrease of TSS content with

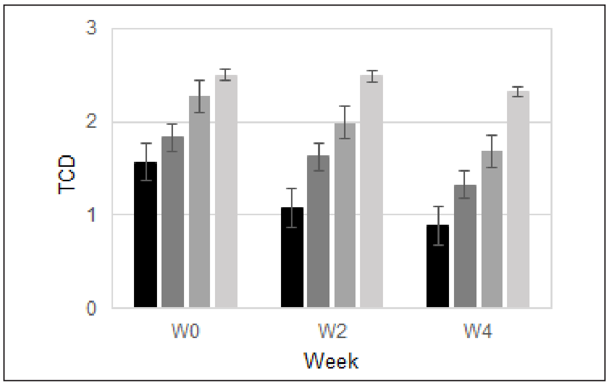

Figure 1. Total colour difference (TCD) of tomato sauce with purslane during 4 weeks

Table 1. Evaluation of colour changes in tomato sauces with purslane

Sample	Week 0				Week 2				Week 4			
	L	a	b	C	L	a	b	C	L	a	b	C
S_0	36.30	8.90	18.07	7.23	35.94	9.57	20.44	7.61	36.66	12.14	23.98	8.08
S_1	35.28	9.69	19.26	7.50	35.44	10.29	21.05	7.80	36.56	11.26	22.38	8.09
S_2	35.43	9.77	19.43	7.53	35.34	10.57	21.56	7.89	35.62	11.33	22.51	8.11
S_3	35.49	10.04	19.86	7.63	36.10	10.65	22.10	7.96	35.73	10.74	22.66	8.14
S_4	35.59	10.24	20.06	7.68	36.24	11.05	22.41	8.06	35.65	10.05	22.75	8.16

Legend: S_0 - tomato sauce without purslane; S_1, S_2, S_3 and S_4 - tomato sauce samples with 1 g/100g, 2 g/100g, 5 g/100g and 10 g/100g purslane, respectively.

Table 2. Physiochemical properties of tomato sauces with purslane leaves

	Mean values ± SD of samples				
Analysed parameters	S_0	S_1	S_2	S_3	S_4
Total soluble substances (°Bx)	9.57 ± 0.50	9.56 ± 0.40	9.49 ± 0.54	9.52 ± 0.11	9.20 ± 0.20
Moisture (%)	86.15 ± 0.51	86.17 ± 1.17	86.21 ± 1.07	86.94 ± 1.64	87.00 ± 0.82
Ash (%)	3.84 ± 0.17	3.46 ± 0.34	3.44 ± 0.37	3.09 ± 0.24	2.81 ± 0.06
Protein (%)	0.12 ± 0.05	0.49 ± 0.09	1.02 ± 0.05	1.46 ± 0.18	1.83 ± 0.01

increasing purslane amount from 9.57 (°Bx) to 9.20 (°Bx) show a benefit of purslane addition by the decrease of sugar content of the sauce. Moisture content of the sauce increase with increasing purslane concentration from 86.15 (%) to 87 (%). This variation of liquid content of the sauces can explain also the TSS decreasing if water is considered to be evaluated by measuring the moisture. In this assessment, account must be taken of the tomatoes and purslane water content. Tomatoes have a 94.5% water content, compared to 92.8% purslane (Nutrition values, [17]). Under these conditions it can be assessed that TSS has a higher value in tomatoes than in purslane leaves. Ash content of the studied sauce decreases with 1% compared to the sample without purslane (from 3.84 (%) for S_0 to 2.83 (%) for S_4). The decreasing of minerals content in the sample with purslane indicated that the tomato contains a higher amount of inorganic matter than purslane leaves.

Concerning the protein content, the addition of purslane significantly increases the amount of protein in tomato sauce from 0.12 (%) to 1.83 (%). This is confirmed by the fact that purslane has the double amount of protein of 4 (%) unlike tomatoes with 2 (%), as shown by previous reported literature reviews (Nutrition values [17]).

The total acidity of the sauces samples was evaluated during one month. From Figure 2 it can be noted that the sample without purslane has a high acidity in the first day comparing with the sample with different purslane concentrations.

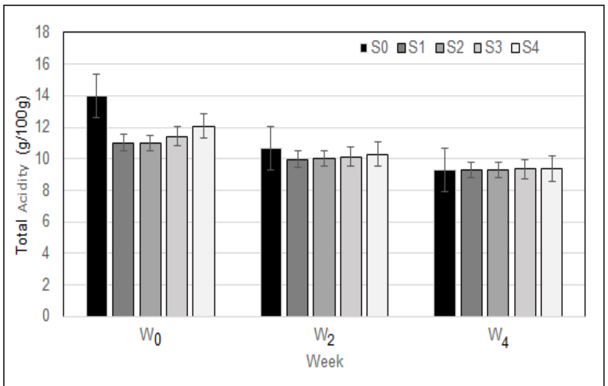

Figure 2. Total acids variation of tomato sauce with purslane during 4 weeks

Regarding the acidity evolution with preservation time it can be observe that the sauces reached a stable acidity value around 9.3 (g/100 g) at the end of the monitoring period.

Tomato sauce water activity (a_w) and pH are presented in Figures 3 and 4.

It can be noted that in the case of samples with purslane both parameters have reached close values ($a_w \approx 9.2$; pH ≈ 4.2) indicating that evidence has reached stability in terms of biochemical changes and equilibrium vapour pressure of pure water at refrigeration temperature has been reached. For the sample without purslane a_w value is very close to the sample with purslane (9.2), but the pH is a little higher, keeping the initial difference of 0.1 units.

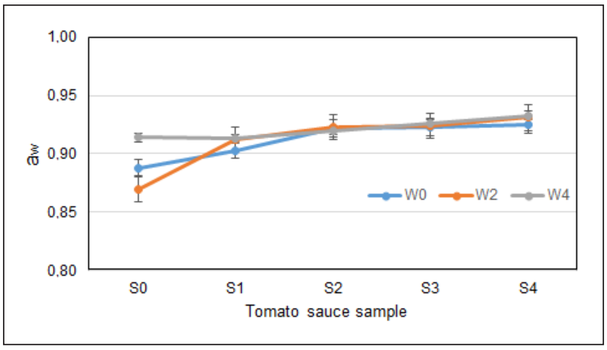

Figure 3. Water activity (a_w) variation of tomato sauce with purslane during 4 weeks

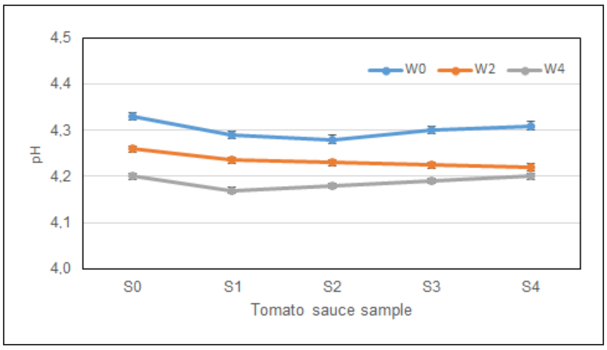

Figure 4. pH (a_w) variation of tomato sauce with purslane during 4 weeks

The effects of water activity and pH can be combined through hurdle technology to control microorganisms more effectively. According to the interaction of pH and a_w for control of spores in food, heat-treatment for the obtaining values the sauce assessment is required ($a_w \approx 9.2$; pH ≈ 4.2) since at those value some microorganisms can be developed (i.e. *Staphylococcus aureus*, *Salmonella* spp. and *Yersinia enterocolitica)* (Singh and Shalini, [18]).

The viscosity of purslane-rich sauces presents a certain type of non-devonian liquid, which changes its viscosity under the action of shear force increase (Figure 5).

Samples with 1 g/100 g additions have high viscosity and good stability in the time (0 - 4 weeks). The viscosity of the sauce with 2 g /100 g purslane shows the same stability trend, unless the sample is retained for 4 weeks with a decrease in viscosity. Samples with additions of 5 and 9 g/100 g have the best viscosity stability over time. The viscosity curves for the addition of 9 m/100 g are very close to 2 and 4 weeks. It can be considered that the addition of purslane leaves leads to sauces with uniform and stable viscosity, with specific appearance.

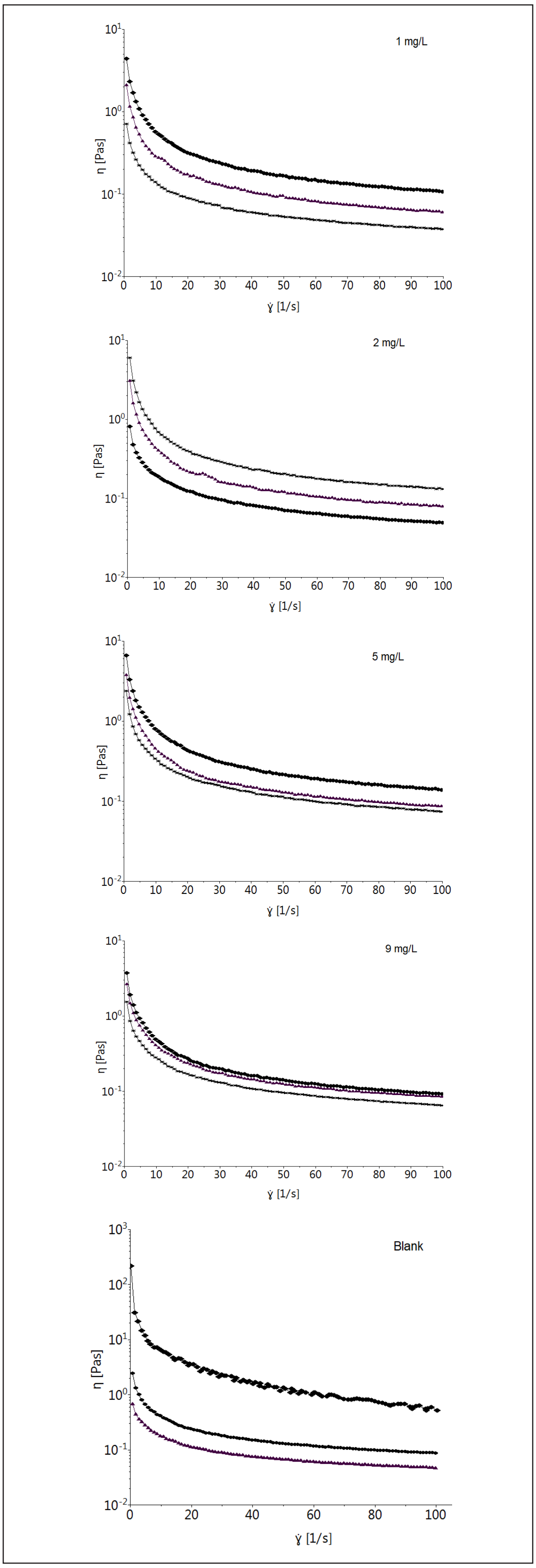

Figure 5. pH (a_w) variation of tomato sauce with purslane during 4 weeks

4. Conclusions

- The tomato sauce enriched with different fresh purslane leaves contributes to the improvement of Omega 3 - 6 balance.

- Sauce characterization indicated that the changes in colour are not significant since the sample with purslane have red-green axis (a) value in the positive region and the colour intensity has a difference of 0.1 units.

- TSS content decrease with increasing purslane amount from 9.57 (°Bx) to 9.20 (°Bx) showing o benefit of purslane addition by the decrease of sugar content of the sauce. The moisture content of the sauce increase with increasing purslane concentration from 86.15 (%) to 87 (%) and the ash content decreases with 1%.

- Addition of purslane significantly increases the amount of protein in tomato sauce from 0.12 (%) to 1.83 (%). According to the interaction of pH and a_w for control of spores in food heat-treated for the obtaining values the sauce assessment is required ($a_w \approx 9.2$; pH ≈ 4.2) since at those value microorganisms can be developed.

- The viscosity of purslane-rich sauces presents a certain type of non-devonian liquid, which changes its viscosity under the action of shear force increase.

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