IN FOCUS

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Investigation of purslane (Portulaca oleracea L.) *as a potential foodstuff*

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1. Abstract

Nowadays, sustainability and environmental awareness play an increasingly prominent role in our daily lives. In addition to a healthy diet, a growing number of conscious consumers increasingly demand variety and the use of ingredients with favourable nutritional parameters that have a low environmental impact on the planet. Purslane (*Portulaca oleracea* L.) is typically known as an undesirable weed in our country and Europe, but its food potential is predestined for much more. Thanks to its worldwide distribution and versatile uses (agriculture, medicine, gastronomy), purslane has come back into scientific focus. The plant is rich in omega-3 fatty acids, especially alpha-linolenic acid, high in antioxidants and vitamins A, C, B6 and E and is a significant source of magnesium, calcium and iron. In our research, total polyphenol and flavonoid content, protein and Klason lignin content of the ground leaves and stems of the plant were investigated, and product development was carried out by preparing test samples enriched with 5%, 10% and 15% powdered purslane. We tested the physical parameters of the test loaves and carried out a sensory evaluation to see how consumers perceived the products we developed. The results showed that the development of food products with purslane powder is feasible, and using the stem and leaf parts of the plant, the enrichment of 5% scored the highest in the sensory evaluation.

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2. Introduction

Purslane (*Portulaca oleracea* L.) is the eighth most common weed worldwide (Aszalósné Balogh et al., 2024; Furkó, 2024). Nowadays, it is also referred to as a „super vegetable", as it is rich in nutrients and has a wide range of uses in gastronomy (Chen et al., 2019; Howes et al., 2023).

Systematically, it can be classified in the phylum *Angiospermatophyta*, the class *Dicotyledonopsida*, the order *Caryophyllales*, the family *Portulacaceae* and the genus *Portulaca* (E. Bálint et al., 1987; Király, 2009).

The purslane is native to the plains of Europe and Asia. It is a cosmopolitan species with a T4 life form and is found in almost all parts of the world due to its drought tolerance and ease of cultivation in different climates. It prefers rainy weather but also occurs in semi-arid and arid areas such as North Africa and Southern Europe. It is also widespread in our country, preferring loose sandy soils, but is also a common weed on loamy soils (Ujvárosi, 1973; Gonella et al., 2010; Chugh et al., 2019).

In terms of the morphology of the vegetative organs, a low-growing plant, spreading stem (10–40 cm long), with a cylindrical and fleshy stem. The leaves are sessile (stalkless), obovate-ovate or lobed, usually 1–2 cm long, dark green and waxy. Flowering is frequent from July until frosts with small yellow flowers, borne singly or in groups in the axils of the leaves or at the end of the stems. The fruit is a 3–7 mm long, oval, obliquely capped, multinucleate capsule. The seeds are 0.7 mm wide, round or kidney-shaped, flattened and brownish black (Ujvárosi, 1973; Hunyadi et al., 2000).

Purslane has a wide range of uses. In agriculture, it can improve soil fertility and enzyme activity due to its phytoremediation capacity, and it can also be involved in the remediation of saline soils (Grieve and Suarez, 1997; Bekmirzaev et al., 2021). Its gastronomic importance is demonstrated by its popular use in the preparation of soups, salads, smoothies or fermented foods due to its sour and salty taste, and the decoction of its dried leaves is consumed as tea. It is popular mainly in the Far East and is considered an essentially everyday food (Uddin et al., 2014; Uddin et al., 2020). The most commonly utilised part is the leaves and stems of purslane, which are typically harvested before flowering.

Thanks to its favourable nutritional parameters, purslane has attracted considerable attention from several directions in recent years. Although known as a weed in the public domain, it is currently considered by the WHO as one of the most useful medicinal plants (Lim and Quah, 2007; Apicella et al., 2023; Carrascosa et al., 2023). The plant contains highly valuable compounds such as polyphenols and flavonoids, organic acids, esters, lignans and is also rich in sterols. Its high antioxidant and omega-3 fatty acid content, significant vitamin A, C, B6 and E content, magnesium, calcium, iron and potassium content make it a species with potential in medicine and the food industry (Alam et al., 2014; Kumar et al., 2022). In addition to its antimicrobial, antiviral, antifungal, antidiabetic and antiasthmatic effects, many studies report anti-inflammatory and wound-healing effects of fat gristle. In ethnobotanical research, the use of the plant as a medicine has been used in diseases such as diabetes, cardiovascular diseases, urinary tract infections, headache, fever, and diarrhoea, but it is also widely used against snake bites or insect stings and in cases of pregnancy risk (Younos et al, 1987; Chan et al, 2000; Chen et al, 2009; Zhu et al, 2010; Faruque et al, 2019; Nemzer et al, 2020; Howes et al, 2023).

With sustainability and an environmentally conscious approach in mind, purslane could be a prospective medicinal and food crop for the future food supply due to its favourable nutritional parameters and good cultivability (Apicella et al, 2023). Overpopulation, climate change and the depletion of natural resources call for an environmentally conscious approach to agriculture and, more narrowly, to the food industry, which focuses on the use of raw materials that can be incorporated into a self-sustainable lifestyle (Obaisi, 2017). A varied and balanced diet is one of the pillars for safeguarding human health, which can ensure a better quality of life (Bánáti, 2022; Rurik et al, 2024). The number of health-conscious dieters is rapidly increasing both in Hungary and globally, and the food industry is constantly innovating to keep pace (e.g. new ingredients, new technologies). Purslane can be an excellent staple for health-conscious, plant-based diets, can be grown with low environmental impact, and the promotion and rediscovery of forgotten plants are important for sustainability (ADM, 2020; Apicella et al., 2023).

The main objective of our work was to explore the potential of the plant for food production. We would like to make the data from the study tangible for the processing industry, and not only to highlight the value of the plant at the centre of the study, but also to contribute to the exploitation of local resources. The results of the research could open up many new avenues for horticulturists and growers who have so far only been concerned with the control and management of purslane.

3. Materials and methods

The purslane, the focus of the study, was collected from a closed garden in Kaba (N47.3558 E21.2743) after flowering in autumn 2023 (Figure 1). Purslane samples were stored frozen after cleaning and soil decontamination. Before use, plant parts were separated into leaf and stem parts by hand sorting and lyophilised. During sample preparation, the leaf and stem parts were pulverised using a coffee grinder for product development and laboratory testing. During our research, total polyphenol and flavonoid content, protein content and cell wall analysis (Klason lignin, glucan content) were determined from the plant. For product development purposes, a test batch was prepared and enriched with „purslane powder" in different proportions. Phylogenetic analysis was performed on the flour used in the test, and physical tests (loaf volume, shape ratio, baking loss) were also performed on the enriched test loaves. The test loaves enriched with purslane powder and our control sample without purslane powder were subjected to a sensory evaluation by tasting and filling in a questionnaire. In all cases, our laboratory tests were performed in triplicate in the laboratories of the Institute of Food Science, the Institute of Agricultural Chemistry and Soil Science and the Institute of Applied Plant Biology of the Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen.

Figure 1*: Purslane (Portulaca oleracea L.)*

3.1. Soil analysis

From the collected soil, the following parameters were determined in the laboratory of the Institute of Agricultural Chemistry and Soil Science of the University of Debrecen: pH, humus content (w/w %), NO2+NO3-N content, and the easily absorbable phosphorus and potassium content of ammonium lactate. In addition to this series of tests, Arany's plasticity index (KA) was also determined.

Soil chemistry was determined in a 1:2.5 ratio of distilled water and KCl. The measurement was carried out with a pH meter (JENWAY 570 portable pH / mV / oC meter) by immersing the glass electrode in the solution after the solution had been standing for 12 hours (Buzas 1988).

The humus content was determined by colourimetry (Philips Pye Unicam PU 8610 UV/VIS Kinetics Spectrophotometer). Potassium dichromate (K2Cr2O7) is a strong oxidising agent in the presence of oxidising agents in acidic media. Dichromate is reduced to chromium salts, while the solution changes colour from orange to green. The amount of excess potassium dichromate was measured colourimetrically (580 nm wavelength) (Buzás 1988).

The nitrate-N content of the soils was determined according to the method of Felföldy (1987) using the sodium salicylate method. The measurement was carried out with a spectrophotometer (Philips Pye Unicam PU 8610 UV/VIS Kinetics Spectrophotometer) at a wavelength of 430 nm. Determination of the easily soluble phosphorus and potassium content of the soils was carried out using 0,1 M ammonium lactate (AL) extractant at pH 3.7. Phosphorus content: 10 cm^3 of the extract was precipitated, 15 cm^3 of ammonium molybdenate sulphuric acid was added and supplemented with 1 cm3 of ascorbic acid tin chloride solution for reduction to give a blue colour. The intensity of the resulting colour was photometric at 660 nm (Philips Pye Unicam PU 8610 UV/VIS Kinetics Spectrophotometer). The potassium content was determined from the filtrate using a flame photometer (VARIAN AA-20 PLUS + GTA 100 Atomic Absorption Spectrometer + Graphite Furnace module), based on the intensity of the flame staining (Egnér et al., 1960).

3.2. Determination of Klason lignin and glucan content

Klason lignin content was determined according to the Hägglund method (Sluiter, 2008). The lignin content of the sampled raw material was determined gravimetrically so that the G4 glass filters were properly prepared. They were placed in the furnace (Nabertherm L5/11/B510) for 3 hours at 550°C before measurement, then cooled in a desiccator and accurately weighed after cooling. As they were used the next day, they were placed in a drying oven (BINDER E 28) at 105°C after the furnace.

In the first step, 0.5 g of ground leaf and stem samples, dried overnight at 105°C, were weighed in three replicates per sample on an analytical balance into liquid bottles and 2.5 ml of 72% H2SO4 was added using an automatic pipette. The samples were thermostated in the presence of sulphuric acid for 2 hours and diluted with 75 ml distilled water. The samples were then placed in sealed liquid bottles without mixing in an autoclave (121°C; Systec 3850 EL) for thermostatting for one hour. After claving, the solutions were filtered through pre-annealed and weighed glass filters using a vacuum.

About 2 ml of the filtrate was filtered through a 0.45 μm pore diameter filter into HPLC tubes. Glucose concentrations were determined by high-performance liquid chromatography (HPLC) (Waters Alliance 2695 Separations module; column: Phenomenex Luna Omega Sugar 250 x 4.6 mm, 3 μm; eluent: acetonitrile:water = 75:25; flow rate: 1 ml/min; 35 °C). From the latter, the glucan contents were calculated for the original sample, based on the dry mass of the sample, the liquid volume and the mass increase during hydrolysis. The solid fraction remaining on the glass filter was washed to neutral with hot distilled water.

The glass filters were then placed in a drying oven overnight at 105°C. After drying and cooling in the desiccator, their mass was measured. The dried solid fraction was then incinerated in an oven at 550°C for 6 hours, and the mass of the insoluble inorganic components was determined. The Klason-lignin content of the original sample is the dry mass of organic matter in the solid fraction relative to the measured dry mass. Klason lignin is defined as the solid residue after hydrolysis corrected for ash content (Equation 1). Glucan contents were determined by taking into account the depolymerisation factor of monosaccharides (Sluiter, 2008). Glucan includes all polysaccharides composed of glucose monomers.

Equation 1. *Calculation of lignin content*

$$\text{lignin (\%)} = \frac{m_0}{(m_2-m_1)-(m_3-m_1)} \times 100$$

m_0: exact mass of 0,5 g of dried sample (g),

m_1: mass of G4 glass filters (g),

m_2: mass after drying at 105°C (g),

m_3: mass after 550°C annealing (g).

3.3. Determination of protein content

Protein content was determined according to the method of Bradford (1976). 20 mg of lyophilised, powdered stem and leaf samples were weighed in triplicate in Eppendorf tubes. To the weighed samples, 1 ml of distilled water was added. The Eppendorf tubes were vortexed and placed in an ultrasonic water bath for 1 hour. Next, the suspended particles were removed by centrifugation at 10000 RPM for 4.5 min. After centrifugation, 50 μl of the suspension was weighed into another Eppendorf tube. To the measured sample, 50 μl of sodium chloride solution was added. Then, 1 ml Coomassie Blue (Bradford) reagent was added to the sample. The tube was thoroughly mixed to ensure that the reagent was well mixed with the samples. The mixture was incubated for 2 minutes at room temperature. The incubated samples were transferred to cuvettes for spectrophotometric measurement. For the blank sample, 100 μl NaCl and 1 ml Bradford reagent were used. The absorbance was measured at 595 nm (Ultrospec 2100 pro, Amersham BioSciences Spectrophotometer). A standard curve was used to calculate the concentration.

3.4. Determination of total polyphenols

Total polyphenol content was determined according to the method of Singleton and Rossi (1965) with minimal modifications. A total of 20 mg of stem and leaf samples were weighed, and 1 ml of methanol: distilled water (70:30) was added, vortexed and incubated in an ultrasonic water bath for 30 min. The sample was then centrifuged at 13.200 RPM for 3 minutes. The supernatant was filtered through a 0.45 μm filter into an Eppendorf tube, and 1250 μl of Folin–Ciocalteu reagent was then added to 50 μl of supernatant. After waiting 1 min, 1000 μl of 0.7 M Na2CO3 was added to the sample and incubated in a water bath at 50 °C for 5 min. The cuvettes were loaded onto a mark, and the absorbance was measured with a spectrophotometer at 760 nm (Ultrospec 2100 pro, Amersham BioSciences Spectrophotometer). The blank sample was a mixture of 1250 μl of Folin–Ciocalteu reagent and 250 μl of MetOH:DW. The total phenol content was calculated using a calibration curve obtained using the gallic acid standard.

3.5. Determination of flavonoid content

Flavonoid content was determined according to the method of Kim et al., (2003) with minimal modifications. The determination was based on the complexation of flavonol- and flavone-type compounds with aluminium chloride in a stoichiometric reaction in an acid medium. The colour intensity of the resulting complex indicates the amount of compounds present in the solution. A routine standard was used to prepare the calibration curve. For the measurement, 0.5 ml of the sample was added to 4.5 ml of the Al solution.

The Al solution contained 5 ml of 10g ml-1 AlCl3 solution, 5 ml of 1 M KOac solution, 75 ml of methanol and 140 ml of distilled water. The measurement was performed at 415 nm (Ultrospec 2100 pro, Amersham BioSciences Spectrophotometer). The results were obtained in routine equivalents according to the calibration equation.

3.6. Farinograph examination

It is common practice to perform farinographic tests (MSZ 6369/6:1988, LABOR MIM OA 205) to determine the behaviour, water absorption and rheological properties of different flours and doughs. To remove possible impurities, the flour we wanted to use in our product development was first sieved. The moisture content of the flour sample was determined using Inframatic 8620 equipment, and then a dough was prepared from the flour and distilled water. The exact amount of flour used was determined from the moisture content of the flour using the standard. During the test, the apparatus records the resistance of the dough to kneading, i.e. the behaviour of the dough and the degree of any softening. The device can determine the exact water absorption of the flour to achieve the right consistency. The value thus determined was used in the preparation of the test loaves.

3.7. Making test loaves

During our product development, we prepared test loaves by adding leaf and stem parts (powdery) of purslane to our prototype product according to the standard MSZ 6369/8:1988 (MSZ 6369/8:1988). The recipe of the test loaves was defined in terms of flour weight (w/w %): 100% flour, 3% yeast, 2% salt and 0.5% sugar. For the flour used in the study, the water absorption capacity and the quality index were also established beforehand. For the prototype products, enrichment of 5%, 10% and 15% of the purslane stem and leaf powder was carried out, resulting in a total of 7 test loaves (including a control sample without purslane powder). The process of making loaves started with the weighing of dry and wet ingredients. The yeast and sugar were dissolved in a part of the kneading water, then added to the previously weighed and mixed dry ingredients and a homogeneous dough was obtained by machine kneading for 5 minutes at 28°C. The dough was then placed in a kneading machine (FM F-608), where it was left to mature for 30 minutes at 31°C and 85% relative humidity, and then the loaf was shaped into a round loaf using 20 rolling movements. The dough was placed in a floured press (seam side up) and left to rise for 60 min at 31°C and 85% relative humidity (Figure 2). The risen loaves were placed on baking paper, sprayed with water and baked (RXB 606, Hot air mixer oven) for 32 min at 260°C (96% relative humidity).

Figure 2*: Test loaves waiting to be baked*

3.8. Testing the physical parameters of test loaves

3.8.1. Determination of test loaves' specific volume

The determination of the test loaves' volume is usually used for bread or bakery products and provides information on the quality, texture and airiness of the food product. One of the best-known volumetric tests is the displacement method, whereby a loaf of bread is placed in a container filled with rapeseed of known volume. The volume of rapeseed displaced by the loaf is equal to the volume of the loaf. The specific volume is obtained by dividing the volume of the cooled loaf by its mass (Equation 2).

Equation 2. *Determination of specific volume*

$$\text{Specific volume} \left(\frac{cm^3}{g}\right) = \frac{V}{G}$$

V: loaf volume(cm3)

G: loaf weight (g)

3.8.2. Determination of shape ratios

The determination of the shape ratios was an important parameter for the determination of baking time and quality parameters, which is usually performed for bread or loaves, but can also be relevant for other bakery products during product development. After the loaves had cooled, they were cut in half (Figure 3), placed face down on a sheet of paper and then drawn around. A ruler was used to measure the maximum width and maximum height of the loaf in the longitudinal direction, and the shape quotient, a dimensionless number, was determined using **Equation 3.**

Equation 3. *Determination of shape ratios*

$$\text{AH} = \frac{M}{L}$$

M: loaf width (mm),
L: loaf height (mm).

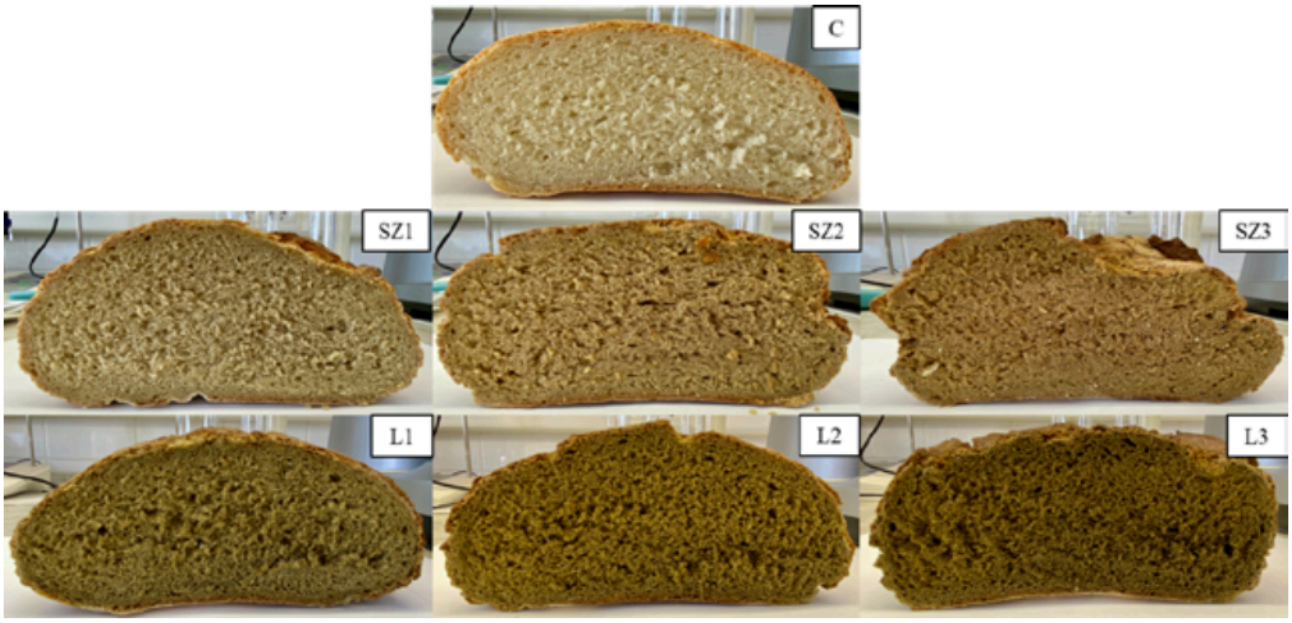

Figure 3: *Determination of the share ratio of test loaves*
C: control sample; SZ1: 5% enrichment with stem; SZ2: 10% enrichment with stem; SZ3: 15% enrichment with stem; L1: 5% enrichment with leaves; L2: 10% enrichment with leaves; L3: 15% enrichment with leaves

3.8.3. Determination of the loss of baking

Baking loss was carried out on the day of product development after the test loaves had cooled. The weight of the loaves was measured both before and after baking, and the baking loss was determined according to **Equation 4** (Kiss, 2009).

Equation 4. *Determination of the loss of baking*

$$\frac{m_1 - m_0}{m_1} \times 100$$

m_0: weight after baking (g),
m_1: weight before baking (g).

3.9. Sensory analysis

Sensory/organoleptic testing plays an important role in food product development, assessing the acceptability and quality of the product. In the sensory evaluation (**Figure 4**), we aimed to assess 4 parameters of the test loaves (and the control sample without purslane powder) enriched with purslane powder: appearance, smell, taste and texture. A total of 27 participants were university citizens (lecturers and students). Our judges described the test loaves on a scale of 1 to 5 (simple ranking), where 1 was very bad and 5 was fine and asked them to answer a few questions, such as whether they were familiar with purslane, whether they had ever consumed purslane, whether they would buy the product we developed, etc. The full questionnaire is attached.

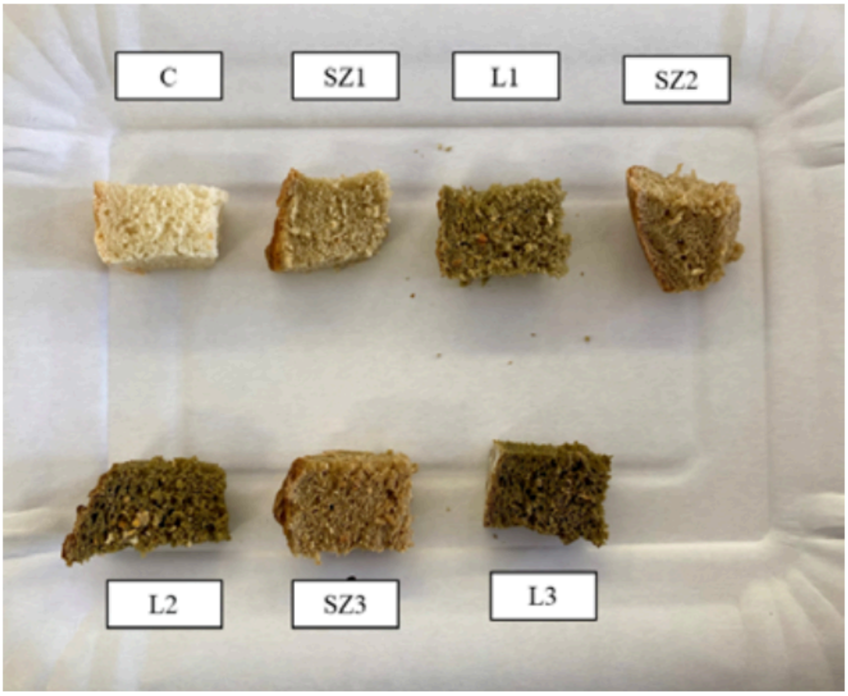

Figure 4*: Sensory analysis of test loaf samples*
C: control sample; SZ1: 5% enrichment with stem; SZ2: 10% enrichment with stem; SZ3: 15% enrichment with stem; L1: 5% enrichment with leaves; L2: 10% enrichment with leaves; L3: 15% enrichment with leaves

4. Results

All laboratory analyses were carried out in triplicate, and the values reported in the manuscript represent the corresponding means. In certain cases – such as sensory evaluation, baking loss, or the determination of physical parameters of the loaves – the results derive from deterministic calculations.

4.1. Soil test results

The soil parameters (**Table 1**) show that the soil is clay loam with medium humus and CaCO3 content. The latter is due to the slightly alkaline chemistry of the soil.

Table 1: Soil test results

Plasticity index	pH		Humus	$CaCO_3$	NO_3-N	AL-P_2O_5	AL-K_2O
K_A	H_2O	KCl	%	%	(mg 1000 g^{-1})		
46.00	7.92	7.28	3.10	10.85	49.42	1847	1005.0

4.2. Klason lignin content

The average Klason lignin content of the purslane samples ranged from 4.90–14.1% (**Figure 5**). The leaf samples showed a higher Klason lignin content, with an average of 14.1%, while the Klason lignin content of the stem samples was 4.90%.

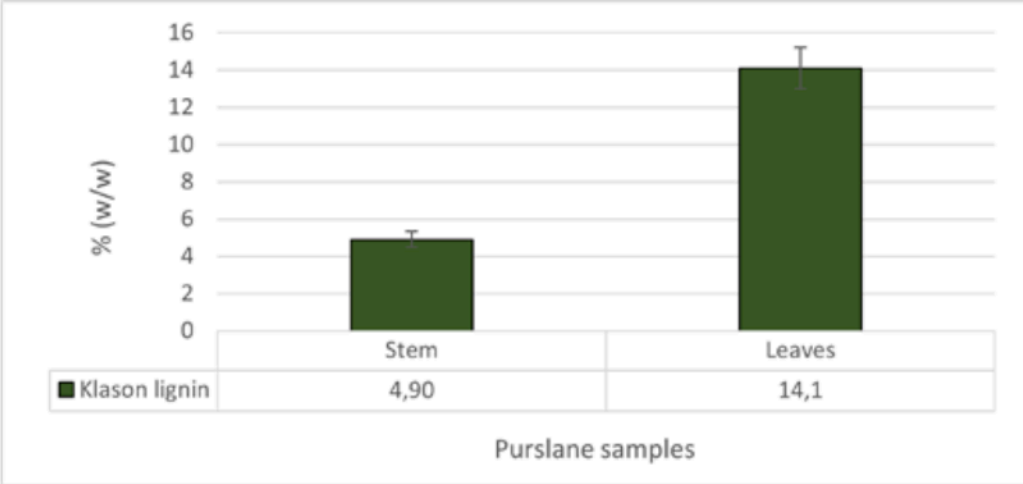

Figure 5: *Klason lignin content of purslane samples*

4.3. Glucan content

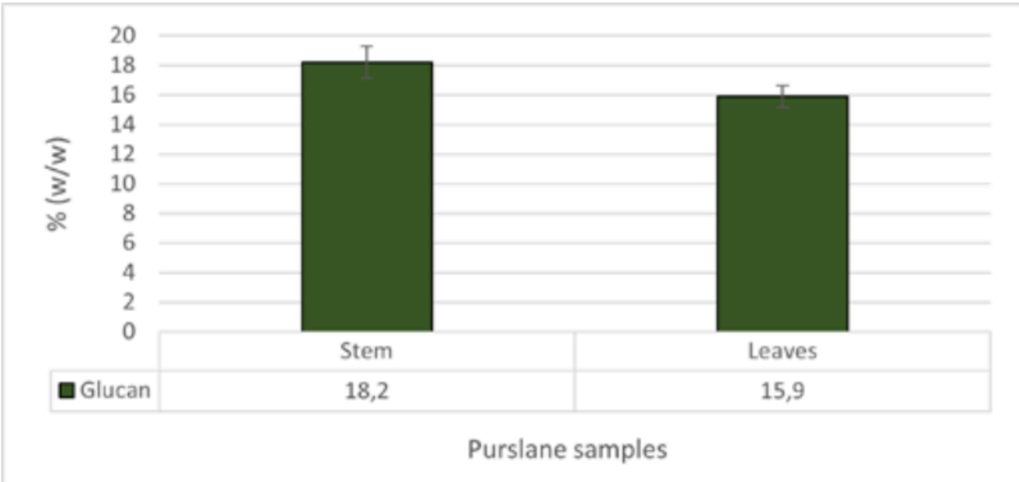

Figure 6: *Glucan content of purslane samples*

The average glucan content of the purslane samples ranged from 15.9 to 18.2%, as illustrated in **Figure 6**. Stem samples had a higher glucan content, with an average of 18.2%, while leaf samples had a glucan content of 15.9%. In our tests, we also tried to determine other soluble sugars (fructose and sucrose), but we could only detect glucose, from which we calculated the glucan content of the purslane samples.

4.4. Protein content

From the tests performed, it can be concluded that the protein content of the purslane samples was higher than 110 mg/100g DW in all cases. The average water-soluble protein content of the stem samples was 112.9 mg/100g DW, while that of the leaf samples was 188.7 mg/100g DW (**Table 2**).

4.5. Total polyphenol and flavonoid content

The total polyphenol content was 387.5 mg GAE/100g for leaf samples and 133.4 mg GAE/100g for stem samples. The flavonoid content of the leaf samples was 21.3 mg rutin eq/100g, and that of the stem samples was 12.1 mg rutin eq/100g (**Table 2**).

Table 2: The composition of the purslane

	Leaves	Stem
Total polyphenol	387.5±1.86 mg GAE/100g	133.4±0.85 mg GAE/100g
Flavonoid content	21.3±1.78 mg rutin eq/100g	12.1±0.23 mg rutin eq/100g
Protein content	188.7±0.39 mg/100g	112.9±0.08 mg/100g

4.6. Farinograph examination

The farinograph (QA-205) test (Figure 7) showed a score of 79.4, which placed the flour in the A2, high-quality category. From the preliminary tests, it was found that the flour sample had a protein content of 14.99%, moisture content of 10.61%, gluten content of 37.63%, ash content of 63% and water absorption of 15.2%.

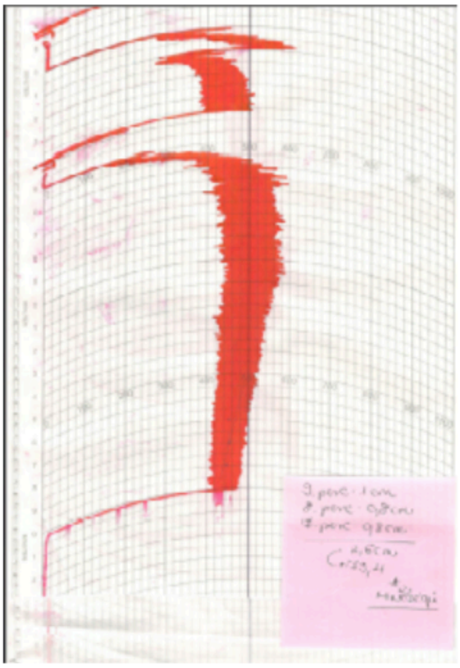

Figure 7*: Farinograph test result*

4.7. Physical parameters of test loaves

The test loaves had an average weight of 445.63 g. No significant differences were observed in the weights of the test loaves enriched with purslane powder. Sample 2 (SZ1), enriched with 5 % stem dry powder, had the lowest weight and Sample 3 (L1), prepared with 5 % leaf powder, had the highest weight (**Table 3**). The average volume of the test samples was 550 cm^3. With the addition of leaf and stem dry powder, the volume of each test specimen decreased, i.e. they became denser. The largest volume after the control sample was sample 5 (680 cm^3), which was prepared with 10% leaf powder (L2). The effect of each enrichment was generally to reduce the volume values by half.

Table 3: Physical parameters of our test loaves

Sample number	Sample code	Flour and purslane powder proportion (%)	Test loaves weight (g)	Test loaves volume (cm^3)
1.	C	100% flour – 0% purslane powder	445.68	1230
2.	SZ1	95% flour – 5% stem powder	442.45	600
3.	L1	95% flour – 5% leaves powder	449.13	510
4.	SZ2	85% flour – 10% stem powder	447.91	580
5.	L2	85% flour – 10% leaves powder	447.25	680
6.	SZ3	80% flour – 15% stem powder	443.04	290
7.	L3	80% flour – 15% leaves powder	443.99	550

4.7.1. Specific volume

The average specific volume of the test samples was 1.42 cm^3/g (**Figure 8**). Sample 6 (SZ3: 1.53), made with 15% stem powder, had the highest specific volume after the control sample (1:2.76). None of the test samples prepared reached the specific volume as specified.

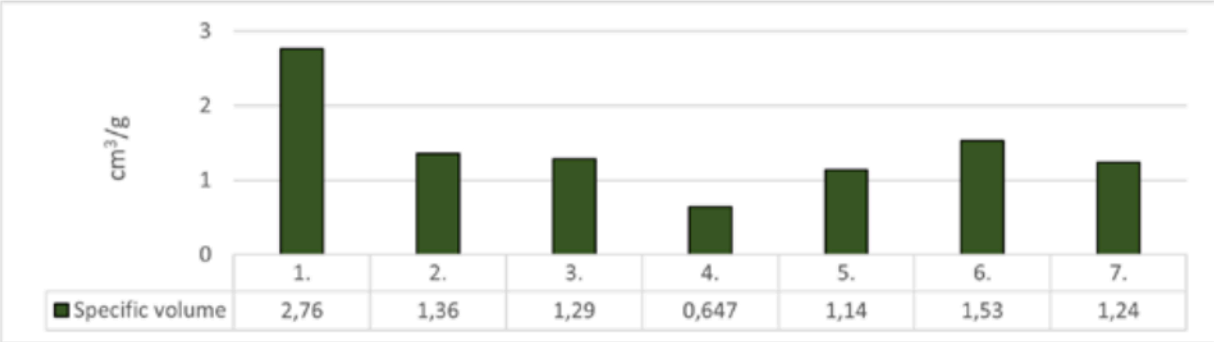

Figure 8: *Specific volume of the test loaves*

4.7.2. Shape ratio

The average shape ratio of the test loaves was 1.90 (**Figure 9**). Samples 4 (SZ2: 1.63) and 6 (SZ3: 1.63), made with 10% and 15% stem dry powder, had the lowest shape ratio, height, width and the most compact structure. Only sample 3 (L1: 2.21), prepared with 5% leaf powder, achieved the shape quotient found in the specification.

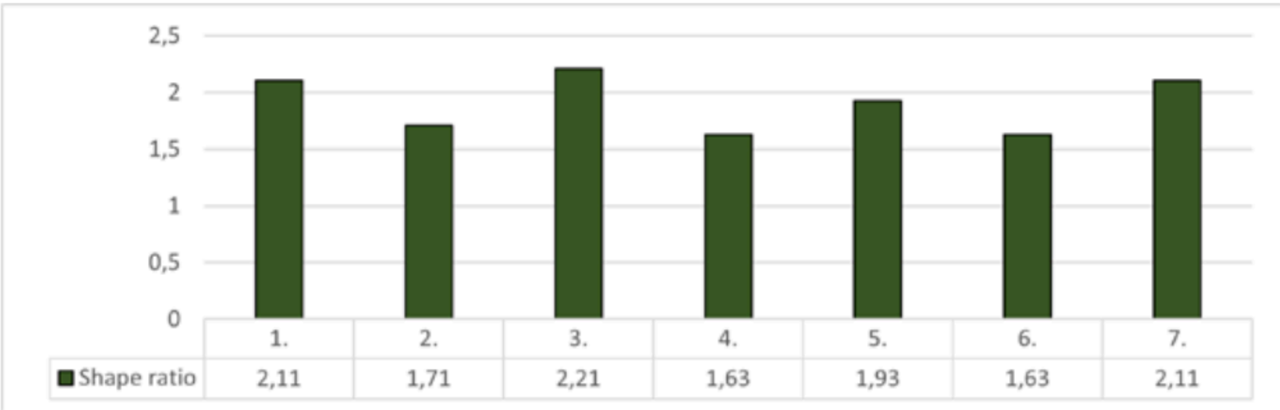

Figure 9: *Shape ratio of the test loaves*

4.7.3. Baking loss

The average baking loss was 8.053% (**Figure 10**). The control sample had a baking loss of 12.74%, which decreased with different percentages of leaf and dry powder added in each case. The lowest baking loss was achieved by sample 6 (SZ3 – 3.86%), which was a test loaf with 15% enrichment with stem dry powder.

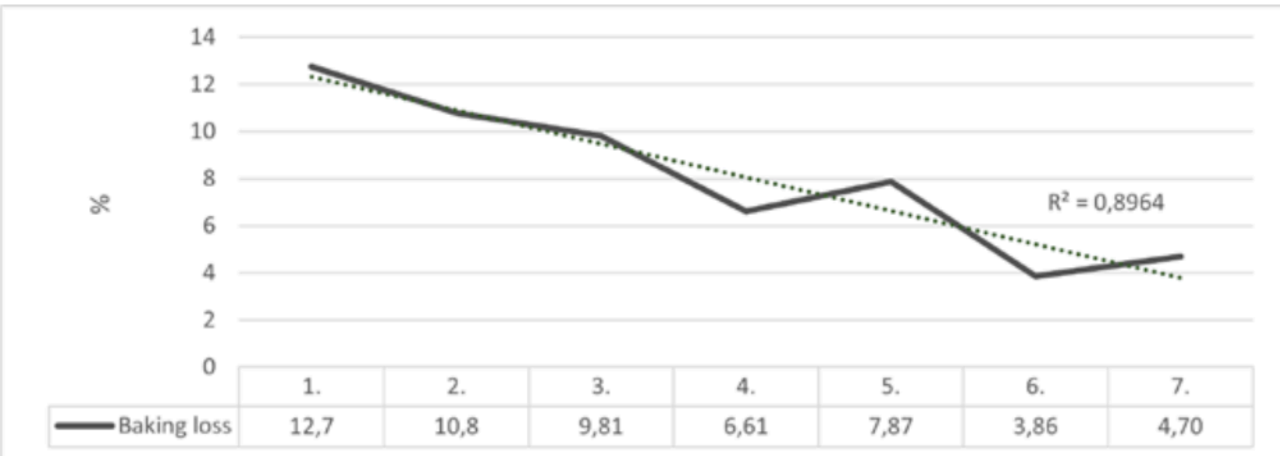

Figure 10: *Baking loss of the test loaves*

4.8. Sensory analysis

48.1% of the 27 people who tried the purslane-enriched test loaves were female, and 51.9% were male. The age proportions in the survey ranged widely. Two age groups were the most dominant in the study: 26–35 years and 36–45 years. 70.4% of the respondents did not smoke, and 63% ate bread daily. 85.2% of the survey participants had heard of the plant before, but only 11.1% had consumed it. Except for one respondent, no one had ever come across a food product containing purslane. The study also aimed to assess the conscious consumption of the tasters. For 20 of the participants, the food products they bought and consumed needed to have some positive value. A statement of the rating on a scale of 1 to 5 was prepared based on the average scores (Figure 11).

The evaluators found it particularly unusual that the addition of leaf powder to the test loaves resulted in a very strong green colour. The most spectacular green colour was achieved by sample 7 (L3) with 15% enrichment. In terms of appearance, sample 3 (L1) and sample 7 (L3) scored the same. The highest score was obtained by sample 3 (L1) with 5% leaf powder addition, and the loaves with 10% leaf powder (L2) were equally rated in all aspects. Sample 5 (L2) was the most appealing to the judges in terms of taste, and Sample 3 (L1) in terms of smell. When evaluating the products made with dry powder, the judges considered as negative the presence of some larger pieces of stem left over from the grinding process.

Based on all aspects of the survey, the test loaves (SZ1, L1) with 5% purslane powder were the best performing. As the amount of purslane powder was increased, the texture of the loaves changed, compaction was observed, and the sensory test scores were both reduced. However, the overall appearance of the loaves was positively influenced by the strong colour change due to the addition of 15% powder. 66.7% of the evaluators would be happy to buy our purslane powder-enriched products.

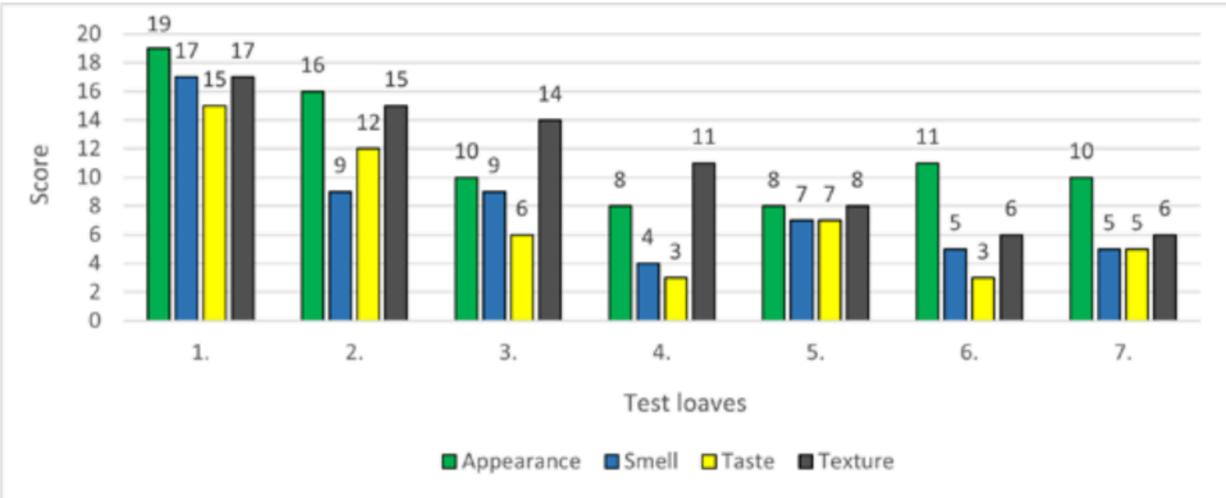

Figure 11: *Sensory test results*

5. Conclusions

Nowadays, in different parts of the world, purslane is of great importance due to its nutritional and dietary effects and the above-mentioned bioactive compounds. Purslane is a noteworthy plant because of its wide range of uses, covering nutritional, medicinal, agricultural and environmental aspects. Its global distribution and its abiotic stress tolerance properties make it a secure candidate for the future sustainable development of agriculture in Asia. In our country, despite its current status as a weed in public and professional circles, it could be a perspective species for the food industry.

Some of the quality parameters of the test loaves were visibly impaired by the addition of different amounts of powdered stems and leaves from the purslane, but despite this, 66.7% of the evaluators would still like to buy the product. Products with a lower enrichment were more positively received by the tasters.

A negative aspect mentioned in the evaluation was that the taste and smell of the test loaves were affected by the characteristic salty and sour taste of the plant. In this respect, it would be worthwhile to complement the enrichment of purslane with other herbs such as garlic, ramsons or dried tomatoes in future product developments.

The test loaves with added leaf powder were characterised by a strong green colour, which the judges rated very positively. In this respect, it would be worthwhile to use leaf powder as a natural colouring agent in other food products, e.g. in dry pasta or bakery and confectionery products.

When making the loaves again, it would be better to grind the ground stem into even smaller particles, sieve and possibly separate them by size. The technological step described above would presumably avoid a denser structure of the loaves and would also give a more positive evaluation of loaves enriched with higher dry powder content.

We also plan to further develop the production of controlled green biomass under greenhouse conditions and use it to carry out further replicated studies. We also want to make the data from the basic research more tangible for the processing industry. Currently, the processing and storage of purslane is a challenge for both agriculture and the food industry, which we would like to address through further research. In the future, we plan to study the antimicrobial effects of the plant on bacteria of concern to the food industry.

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Annex

Purslane test loaf questionnaire

1. Gender? *
   - Female
   - Male

2. Age? *
   - Under 14 years old
   - 14–18 years old
   - 18–25 years old
   - 26–35 years old
   - 36–45 years old
   - 46–55 years old
   - Above 55 years old

3. Do you smoke? *
   - Yes
   - No

4. Have you ever heard of purslane (*Portulaca oleracea* L.)? *

   

   - Yes
   - No

5. Have you ever eaten purslane? *
   - Yes
   - No

6. Have you ever come across a food product that contained purslane? *
   - Yes
   - No

7. Is it important to you that the food you eat has some additional nutritional value over and above the basic nutritional value (e.g. low-carb, high-fibre, no added sugar, low-carb, no sugar)? *
   - Yes
   - No

8. The loaves are rated on a scale of 1–5:

Sample 1 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

9. The loaves are rated on a scale of 1–5:

Sample 2 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

10. The loaves are rated on a scale of 1–5:

Sample 3 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

11. The loaves are rated on a scale of 1–5:

Sample 4 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

12. The loaves are rated on a scale of 1–5:

Sample 5 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

13. The loaves are rated on a scale of 1–5:

Sample 6 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

14. The loaves are rated on a scale of 1–5:

Sample 7 *

(1–very bad, 2–bad, 3–adequate, 4–good, 5–fine)

Parameters	1	2	3	4	5
Appearance					
Smell					
Taste					
Texture					

15. If you saw this product on the shelves, would you buy it? *
    - Yes
    - No

16. How frequently do you eat bread? *
    - Daily
    - 1–2 times a week
    - 3–4 times a week
    - I eat other bakery products
    - I do not consume

Thank you for contributing to the success of our research by filling in the form!