THE INFLUENCE OF PARSLEY (*PETROSELINUM CRISPUM*) ON METABOLISM: FROM BIOACTIVE COMPOUNDS TO THE DEVELOPMENT OF FUNCTIONAL FOODS

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RESEARCH ARTICLE

Abstract
Parsley (Petroselinum crispum), an aromatic plant traditionally used in both gastronomy and folk medicine, has attracted increased interest in recent decades due to its complex phytochemical profile and multiple health benefits. Numerous studies have confirmed the presence in the leaves and roots of parsley of bioactive compounds such as flavonoids (apigenin, luteolin), coumarins, volatile oils, vitamins and minerals, each of which have important roles in modulating metabolism. The aim of the work is to design a functional food that makes the most of both the nutritional and therapeutic potential of parsley.
The results suggest that parsley can be considered a promising functional ingredient, but confirming its metabolic benefits requires controlled clinical trials and rigorous safety evaluations.

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In recent decades, the increase in the incidence of metabolic diseases such as type II diabetes, metabolic syndrome, and obesity has led to an increase in interest in preventive and adjuvant food solutions.

Functional foods, defined as products that offer physiological benefits in addition to simple basic nutrition, are considered a valuable tool in promoting public health.

Parsley (*Petroselinum crispum Mill.*) is highly valued not only gastronomically, but also as a functional food with beneficial effects on health. Parsley leaves are rich in effective antioxidants, and they are widely used in various food applications. A detailed phytochemical examination carried out on parsley leaves reveals the presence of diverse chemical groups, including catechinic tannins, gallic tannins, flavonoids, saponosides, mucilages, and coumarins. These findings confirm the antioxidant properties of parsley, making it a suitable contender for long-term incorporation into the diet (Wong & Kitts, 2006).

INTRODUCTION

Parsley (*Petroselinum crispum*), an easily accessible aromatic plant that is widely cultivated and used, has multiple biological properties confirmed in the literature (Gnintoungbe et al, 2023). The leaves, seeds, and roots of parsley (*Carum petroselinum*) contain volatile oils such as apiol and myristicin (Abbasabadi et al., 2013), as well as flavonoids, beta-felandrene, bergapten, and vitamins A and C (Petropoulos et al., 2004; Díaz-Maro et al., 2002). Modern studies indicate antioxidant (Zhang et al., 2006), anti-inflammatory (Slighoua et al., 2021; Elgazar et al., 2016), hepatoprotective (Soliman et al., 2016), renoprotective (Alobaidi et al., 2024), and antidiabetic (Punoševac et al., 2021; Moharib, 2016; Almutairi et al, 2023), all correlated with

the presence of bioactive compounds such as apigenin and luteolin (Fernandez de Simon et al., 1992). In traditional medicine, parsley has been used for its diuretic effects (Kreydiyyeh & Usta, 2002; Al- Yousofy et al., 2017), digestive stimulants (Borojeni, 2016), and detoxification, which underlines its long-standing role in the health of populations. Regarding the protective effects of the plant, an ethanolic extract of parsley demonstrates a notable ability to clear liver toxicity, the severity of these changes correlating with the amount administered. In addition, parsley extract has been shown to be effective in preventing common side effects, such as proteinuria and low hemoglobin caused by substances such as paracetamol. This suggests a potential purpose of parsley in the management of liver and kidney diseases, specifically in addressing proteinuria and preventing paracetamol-induced renal, liver, and hematological toxicity (Nouioura et al., 2023). In melanoma cases, parsley solution has shown local and systemic therapeutic effects comparable to conventional allopathic treatments, presenting itself as a viable alternative (Sarkar et al., 2023). In traditional Iranian medicine, *Petroselinum crispum* seeds are considered antimicrobial, astringent, gastrotonic, antiseptic, antispasmodic, carminative, sedative and digestive, being used for gastrointestinal disorders, halitosis, inflammation, kidney stones and amenorrhea. The leaves are also used as a food flavoring and cough suppressant, and are used for gastrointestinal disorders, rash, alphosis, dermatitis, macula, rhinitis, hemorrhoids, visual performance, kidney stones, diuretic, and otitis (Ajmera et al., 2019).

Parsley leaves lowered blood glucose and demonstrated hepatoprotective effects in diabetic rats through its antioxidant activity (Bolkent et al., 2004; Ozsoy-Sacan et al., 2006). Yanardağ et al. reported that the antihyperglycemic activity of parsley is not due to the enhancement and regeneration of secretory granules and β cells of pancreatic islets (Eltablawy et al., 2012).

Due to the fact that parsley leaves are aromatic and cannot be included in the diet in any quantity and associated with any food, we set out to include them in a functional food that is well tolerated, can be consumed as such but also associated with other foods.

MATERIAL AND METHOD

For the preparation of functional gummies, the following basic ingredients were used, purchased from pharmacies and local pharmacies: parsley powder, hemp oil, gelatin, glycerin, citric acid, maple syrup, agave syrup, and distilled water (Table 1).

Table 1

Raw materials and excipients

Ingredient	Quantity used	Functional role
Parsley powder	1 g/100 g product	Source of bioactive compounds and antioxidants
Hemp oil	5 g/100 g	Source of bioactive compounds and antioxidants
Gelatin	10–20 g/100 g (depending on the formula)	Source of bioactive compounds and antioxidants
Glycerine	5–10 g/100 g (depending on the formula)	Source of bioactive compounds and antioxidants
Citric acid	0,5 g/100 g	Source of bioactive compounds and antioxidants
Maple syrup	0,5 g/100 g	Source of bioactive compounds and antioxidants
Agave syrup	20 g/100 g (Formula 2)	Alternative natural sweetener
Distilled water	q.s. up to 100 g	Alternative natural sweetener

The following equipment and utensils were used to make the preparations: precision electronic scale, electric induction hob, temperature-resistant stainless steel vessels, Berzelius glasses, glass rods for homogenization, silicone molds (diamond and spiral) for pouring jellies, refrigerator (4°C) for storing products.

Two distinct gummy gummies formulas were tested:

Formula 1 (maple syrup): gelatin 10 g, glycerin 5 g, citric acid 0.5 g, parsley powder 1 g,

hemp oil 5 g, maple syrup 20 g, water up to 100 g;

Formula 2 (agave syrup): gelatin 20 g, glycerin 10 g, citric acid 0.5 g, parsley powder 1 g, hemp oil 5 g, agave syrup 20 g, water up to 100 g.

The gelatin was hydrated and then gradually dissolved in a liquid mixture kept in a water bath at 70–75°C, until the ingredients were completely dissolved. After homogenization, the mass obtained was molded into silicone molds, each jelly weighing about 6–7 g. The molds were left at room temperature for about 30 minutes, then placed in the refrigerator at +4°C for 24 hours. After this interval, the jellies were removed from the molds and stored in hermetically sealed containers in the refrigerator until further analysis. The preparation complied with HACCP (Hazard Analysis Critical Control Points) standards.

The hedonic test is a sensory evaluation technique used primarily to assess the pleasure or satisfaction derived by consumers from a preparation. The term "hedonic" refers to the pleasure or preference for a preparation, and the test is designed to capture the degree of appreciation or disapproval that consumers have for a preparation, often through a structured questionnaire or rating scale. Products are were tested in a controlled environment to minimize external influences on participants' perceptions. The data collected from the hedonic test is analyzed to determine the overall acceptability of the product and to identify any significant differences in consumer preferences. The samples are prepared as follows: they are coded and prepared so that they are identical in appearance (shape, size, weight, packaging). The tasting is carried out in the following way: the product is gently chewed in the oral cavity for a sufficient period of time to allow the taste of the preparation to be observed before and after swallowing. If several samples are present for tasting, a break of at least two minutes is taken after the first sample (possibly a sip of water is taken) before tasting the next sample.

RESULTS AND DISCUSSIONS

Sensory evaluation with the help of the hedonic test

The principle behind this test is based on a method with a high degree of subjectivity. It is a sensory evaluation method widely used to assess consumer preferences and the acceptability of various products, often in the context of food and beverages. The objective is to assess the taste quality of the samples presented by giving the sample a score, using the hedonic scale for assessment.

The sensory testing was carried out by applying the hedonic scale from 1 to 9, where 1 corresponds to the perception "extremely unpleasant" and 9 "extremely pleasant" (Table 2 and 3).

The quality of both preparations was evaluated (Table 2 and Table 3).

Table 2

Sensory evaluation for the first preparation (with maple syrup)

Note	1	2	3	4	5	6	7	8	9
Rating	Extremely unpleasant	Completely unpleasant	Semi unpleasant	Slightly pleasant	Indifferent	Weakly pleasant	Pleasant	Very pleasant	Extremely pleasant
Examinator 1					1				
Examinator 2								1	
Examinator 3							1		
Examinator 4									1
Examinator 5									1
Examinator 6								1	

Examinator 7							**1**		
Examinator 8									**1**
Examinator 9									**1**
Examinator 10								**1**	
Total	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**3**	**4**

Depending on the sensory evaluation, we represented the examiner's preferences in percentages (Image 1).

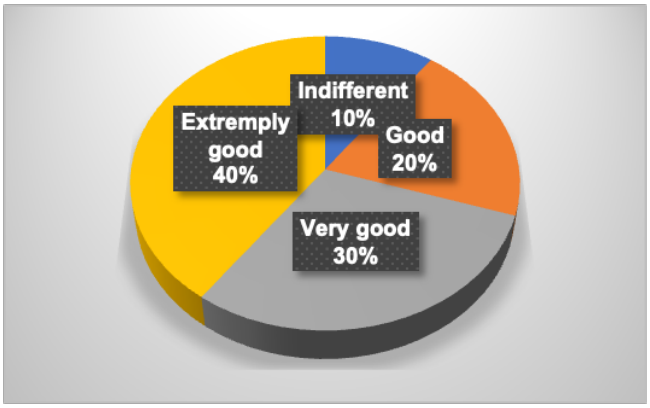

Image 1. **The examiner's preferences in percentages for maple syrup jelly**

Table 3

Sensory evaluation for product number 2 (agave syrup)

Note	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Rating	**Extremely unpleasant**	**Completely unpleasant**	**Semi unpleasant**	**Slightly pleasant**	**Indifferent**	**Weakly pleasant**	**Pleasant**	**Very pleasant**	**Extremely pleasant**
Examinator 1							**1**		
Examinator 2							**1**		
Examinator 3						**1**			
Examinator 4				**1**					
Examinator 5						**1**			
Examinator 6					**1**				
Examinator 7						**1**			
Examinator 8						**1**			
Examinator 9							**1**		
Examinator 10						**1**			
Total	**0**	**0**	**0**	**1**	**1**	**5**	**3**	**0**	**0**

Depending on the sensory evaluation, we represented the examiner's preferences in percentages (Image 2).

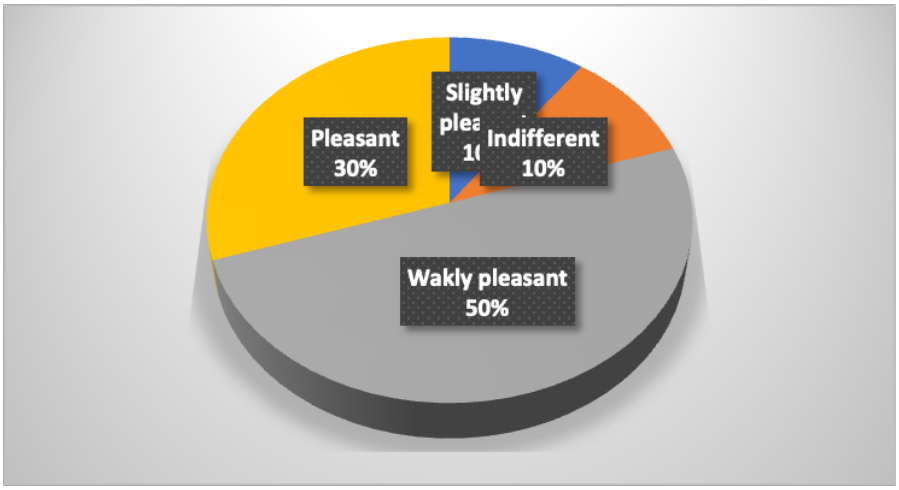

Image 2. **The examiner's preferences in percentages for agave syrup jelly**

The results obtained from the sensory evaluation of the two functional food formulas with parsley leaves were well tolerated, successfully masking the strong parsley aroma.

CONCLUSIONS

The study of the influence of parsley (*Petroselinum crispum*) and its use in the development of functional gummies highlights the significant potential of this plant as a nutritional and therapeutic ingredient. Parsley has proven to be an important source of bioactive compounds, such as flavonoids (apigenin, luteolin), vitamins (C, K, A), and essential minerals (iron, calcium, potassium), substances recognized for their antioxidant, antidiabetic and protective activities at the liver and kidney levels.

The products obtained in the study demonstrated that parsley can be successfully integrated into an attractive food vehicle with good sensory acceptability. The maple syrup formula was perceived as more pleasant, due to its ability to mask the intense taste of the plant, but both variants showed that parsley can be introduced in a modern and easy-to-eat form.

REFERENCES

Ajmera, P., Kalani, S. and Sharma, L., 2019. Parsley-benefits & side effects on health. *International Journal of Physiology, Nutrition and Physical Education*, *4*(1), pp.1236-1242.

Almutairi, A.A., Ahmed, W.E., Algonaiman, R., Alhomaid, R.M., Almujaydil, M.S., Althwab, S.A., Elhassan, A.E.M. and Mousa, H.M., 2023. Hypolipidemic, hypoglycemic, and ameliorative effects of boiled parsley (Petroselinum crispum) and mallow (Corchorus olitorius) leaf extracts in high-fat diet-fed rats. *Foods*, *12*(23), p.4303.

Alobaidi, S., 2024. Renal health benefits and therapeutic effects of parsley (Petroselinum crispum): a review. *Frontiers in Medicine*, *11*, p.1494740.

Al-Yousofy, F., Gumaih, H., Ibrahim, H. and Alasbahy, A., 2017. Parsley! Mechanism as antiurolithiasis remedy. *American journal of clinical and experimental urology*, *5*(3), p.55.

Bolkent, S., Yanardag, R., Ozsoy-Sacan, O. and Karabulut-Bulan, O., 2004. Effects of parsley (Petroselinum crispum) on the liver of diabetic rats: a morphological and biochemical study. *Phytotherapy Research*, *18*(12), pp.996-999.

Borojeni, P., The Role of histaminergic H2 receptors on spasmolytic activity of hydro alcoholic extract of Parsley (Petroselonium crispum) Seeds in adult male Rat, s Ileum.

Díaz-Maroto, M., Pérez-Coello, M. and Cabezudo, M., 2002. Effect of different drying methods on the volatile components of parsley (Petroselinum crispum L.). *European Food Research and Technology*, *215*(3), pp.227-230.

Elgazar, A.F. and Rezq, A.A., 2016. Anti-inflammatory effects of ginger and parsley extracts on rats paw. *Journal of Applied Human Sciences*, *2*(2), pp.31-48.

Eltablawy, N.A., Soliman, H.A. and Hamed, M.S., 2012. Antioxidant and antidiabetic role of petroselinum crispum against stz-induced diabetes in rats. *pathogenesis*, *3*, p.4.

Farzaei, M.H., Abbasabadi, Z., Ardekani, M.R.S., Rahimi, R. and Farzaei, F., 2013. Parsley: a review of ethnopharmacology, phytochemistry and biological activities. *Journal of traditional Chinese medicine*, *33*(6), pp.815-826.

Fernández de Simón, B., Perez-Ilzarbe, J., Hernandez, T., Gomez-Cordoves, C. and Estrella, I., 1992. Importance of phenolic compounds for the characterization of fruit juices. *Journal of Agricultural and Food Chemistry*, *40*(9), pp.1531-1535.

Gnintoungbe, G.S., Medehouenou, T.C.M., Adounkpe, F., Akpovi, C. and Loko, F., 2023. Phytochemical screening, antioxidant activity and safety of Petroselinum crispum (Mill.) AW Hill Apiaceae leaves grown in Benin. *Open Journal of Applied Sciences*, *13*(1), pp.36-50.

Kreydiyyeh, S.I. and Usta, J., 2002. Diuretic effect and mechanism of action of parsley. *Journal of ethnopharmacology*, *79*(3), pp.353-357.

Moharib, S.A., 2016. Antidiabetic and antioxidant effects of parsley (Petroselinum sativum) extract in streptozocin-induced diabetic rats.

Nouioura, G., Kettani, T., Tourabi, M., Elousrouti, L.T., Al Kamaly, O., Alshawwa, S.Z., Shahat, A.A., Alhalmi, A., Lyoussi, B. and Derwich, E., 2023. The protective potential of Petroselinum crispum (Mill.) Fuss. on paracetamol-induced hepatio-renal toxicity and antiproteinuric effect: A biochemical, hematological, and histopathological study. *Medicina*, *59*(10), p.1814.

Ozsoy-Sacan, O., Yanardag, R., Orak, H., Ozgey, Y., Yarat, A. and Tunali, T., 2006. Effects of parsley (Petroselinum crispum) extract versus glibornuride on the liver of streptozotocin-induced diabetic rats. *Journal of ethnopharmacology*, *104*(1-2), pp.175-181.

Petropoulos, S.A., Daferera, D., Akoumianakis, C.A., Passam, H.C. and Polissiou, M.G., 2004. The effect of sowing date and growth stage on the essential oil composition of three types of parsley (Petroselinum crispum). *Journal of the Science of Food and Agriculture*, *84*(12), pp.1606-1610.

Punoševac, M., Radović, J., Leković, A. and Kundaković-Vasović, T., 2021. A review of botanical characteristics, chemical composition, pharmacological activity and use of parsley. *Archives of Pharmacy*, *71*(Notebook 3), pp.177-196.

Sarkar, R., Handog, E.B., Das, A., Bansal, A., Macarayo, M.J., Keshavmurthy, V., Narayan, V., Jagadeesan, S., Pipo III, E., Ibaviosa, G.M. and Podder, I., 2023. Topical and systemic therapies in melasma: A systematic review. *Indian Dermatology Online Journal*, *14*(6), pp.769-781.

Slighoua, M., Mahdi, I., Di Cristo, F., Amaghnouje, A., Grafov, A., Boucetta, N., Bari, A. and Bousta, D., 2021. Assessment of in vivo estrogenic and anti-inflammatory activities of the hydro-ethanolic extract and polyphenolic fraction of parsley (Petroselinum sativum Hoffm.). *Journal of Ethnopharmacology*, *265*, p.113290.

Soliman, H.A., El-Desouky, M.A., Hozayen, W.G., Ahmed, R.R. and Khaliefa, A.K., 2016. Hepatoprotective effects of parsley, basil, and chicory aqueous extracts against dexamethasone-induced in experimental rats. *Journal of intercultural ethnopharmacology*, *5*(1), p.65.

Wong, P.Y. and Kitts, D.D., 2006. Studies on the dual antioxidant and antibacterial properties of parsley (Petroselinum crispum) and cilantro (Coriandrum sativum) extracts. *Food chemistry*, *97*(3), pp.505-515.

Zhang, H., Chen, F., Wang, X. and Yao, H.Y., 2006. Evaluation of antioxidant activity of parsley (Petroselinum crispum) essential oil and identification of its antioxidant constituents. *Food research international*, *39*(8), pp.833-839.