Evaluation of the addition of thickening agents extracted from *Malva parviflora*L. to different types of foods

Suzan Ali Khadour1 , Alla M. S. Al-Baidhani2* , Adnan Ahmad Ali Nizam3 & Ahed Elias Abou Younes4

1Department of Food Science, Faculty of Agriculture, Damascus University, Damascus, Syria. Email: sozan.khaddor@damascucsuniversity.edu.sy.

2Department of Food Science, College of Agriculture, University of Basrah, Basrah, Iraq

*Correspondence Email: alaa.sadkhan@uobasrah.edu.iq ORCID: https://orcid.org/0000-0002-1539-1409

2Department of Plant Biology, Faculty of Science, Damascus University, Damascus, Syria. Email: a.nizam@damascusuniversity.edu.sy ORCID: https://orcid.org/0000-0002-4866-8363

4Department of food science, Faculty of Agriculture, Damascus University, Damascus, Syria. Email: ahed.abouyounes@damascusuniversity.edu.sy ORCID: https://orcid.org/0000-0003-4428-9064 .

Abstract

This research aims to determine some properties of thickening agents extracted from the plants of Malvaceae, it is commonly referred to as Mallow. The thickening agents were extracted using organic solvents (acetone) and water, and dried in a special oven at 50 ° C. When the weight became constant, the agents were stored in a dry powder state for later use. It was found that water extraction gives a higher percentage than alcohol extraction, and then the chemical properties of the extracted agents were determined based on specific tests. The dry powder was identified by its ability to retain water and oil in addition to forming an emulsion. It was found that increasing concentration increases the ability of thickening agents to emulsify. The research provides evidence that these properties make the thickening agents extracted from Malvaceae an important material for the food and pharmaceutical industries. The paper recommends extracting thickening agents found in various plants and utilizing them in various food manufacturing processes as a natural food substance with nutritional value and functional properties that are used in most food industries.

Key words:

thickeners, *Malva(*Mallow), water-holding capacity, Malva parvifloraL., oil holding capacity.

ISSN 2072-3857

Introduction

Food supplements are defined as any substance not normally used as a food itself, nor as a basic component thereof, and which has no nutritional value, that may be added to food for technical or multi-purpose purposes; that includes any minor compounds added to food or during its processing to preserve its flavor, improve its flavor or appearance, or other qualities and properties desired by consumers, and to maintain food safety (1). In the food industry, stabilizers, emulsifiers, thickeners, and gelling agents are often referred to as hydrocolloids, which are water-soluble biopolymers composed of high-molecular-weight sugars (2).

Thickeners are expandable, enlarging substances that, when added to an aqueous mixture, increase their viscosity without substantially changing its other properties. They are complex substances in terms of composition and structure, and can exhibit a wide range of rheological properties when added at different concentrations and under varying conditions. Thickeners and gums contain monosaccharides linked to organic acids, which are closely linked due to the presence of hydrophilic and hydrocolloidal components (3). These materials are carbohydrates with a complex chemical structure and high molecular weight, and are amorphous and form a solution or a gelatinous substance in the presence of water (4). Thickeners contain the sugars pentose and galactose, and in addition to having a terminal carbon atom (located on the other side of the carbonyl chain), the carbon is bonded with an aldohexose in the form of a carboxylic acid called uranic acid (5). Plant-derived sugars such as gums, thickeners, starch, and carboxymethylcellulo se (CMC) are widely used in emulsification products (5).

Malva parviflora.L. is an annual herbaceous plant belonging to the Malvaceae family, argely distributed in areas with tropical, subtropical, and moderate climates of Asia, Africa, and Europe (6), with a height of 30–50 cm, usually, grows in meadows and on roadsides. Leaves and flowers contain condensed substances in varying proportions (7), and the leaves contain antioxidants such as phenolic compounds, vitamins, and carotenoids (8,9). It is a valuable natural source of complex sugars, with excellent potential in pharmaceutical and food applications. Many papers confirm that the sensory, functional and rheological properties of thickeners depend greatly on the extraction method and conditions (5). Although soaking has some drawbacks due to its low efficiency and long extraction time, it is a simple and valuable method for extracting thickeners (10). This method usually involves soaking the raw materials in the selected solvent at room temperature with regular stirring. Acidic solutions, ammonium oxalate and EDTA are used to improve the extraction of thickeners (11).

Natural plant-derived thickeners have effective emulsifying properties by transferring charge to the dispersed droplets and forming Multi molecular shells around the emulsion droplets by increasing the viscosity of the material (12). Good foaming is related to the elastic structure of the thickener, and the foaming property depends on many factors such as the presence of other compounds in the thickener, molecular weight, protein, structure, and carbohydrates. The good foaming property of thickeners is largely related to the elastic structure that can reduce surface tension. Thickeners are widely selected in diets (fruits, vegetables, poultry, and fish), and have contributed to improving the emulsifying properties and water-binding ability of food (5).

The significance of this research stems from its contribution to providing new information about the functional properties of thickeners extracted from the mallow plant; enhancing scientific understanding of the use of these substances in food and pharmaceutical applications. It also emphasizes the importance of developing natural alternatives to industrial thickeners, which will improve public health and reduce reliance on industrial chemicals. It also opens new avenues for research into the use of mallow plants, which may lead to their better exploitation in various industries.

Leave extracts of *M. parviflora* have DPPH radical scavenging activity and might be used as a natural source for bioactive compounds (6). Mallow shoots system has flavonoids, alkaloids, saponins, polyphenols, tannin, and resin (13), and several pharmacological activities in various diseases, Leaves have benefits in swelling and wound management, the plant has antioxidant,anti-carcinogenicity,antibacterial ,antifungal, anti-ulcerogenic (6, 14). Clinical trials represent a challenge in the production of natural anticancer drugs because of difficulties in designing and recruiting participants(15),carrier complexes, nanotechnology and co-crystals represent promising technologies (16).

Hydrogen bonding affects compound solubility, distribution and permeability, making the binding between the drug and receptor easier. Hydrophobic interactions play a pivotal role in establishing the binding affinity between the compound and the receptor and determine the selectivity of the drugs toward the target (17). Natural products are characterized by their biofunctionality and biodiversity and will represent a revolution in cancer management

ISSN 2072-3857

in the upcoming decade owing to their biodegradability and biocompatibility (14).

Materials and Methods

Sample Preparation

Samples of mallow plant were collected from Mesyaf in Hama Governorate, Syria, dried, and the thickening agents were extracted according to the researcher (4), This involved weighing 300g of the dry powder, soaking it in water for 5-6 hours, boiling it for 30 minutes, and then allowing it to stand for one hour to allow all the thickening material to be released into the water. The material was then pressed through a cloth bag to a volume to the filter to precipitate the mucilage (latex) in a quantity three times the total volume of the filter. The thickening material was then separated and dried in an oven at a temperature below 50° C

Determination of the physical and chemical properties of Thickening Materials

○ **Water-Holding Capacity WHC**

An empty 15 ml tube was weighed, then 1 g of powder was placed in it, it was re-weighed, then 10 ml of distilled water was added, and the tube was subjected to shaking for 5 minutes, then centrifugation was performed at 3000 rpm for 30 minutes. The supernatant was removed, the tube was weighed with the residue, and the capacity was calculated (18). Water is retained through the following equation:

$$\mathbf{WHC} = \frac{\textbf{weight of wet sample} - \textbf{weight of dry sample}}{\textbf{weight of dry sample}}$$

○ **Oil-Binding Capacity OBC**

An empty 15 ml tube was weighed, and then 1 g of thickener powder was placed in it and reweighed, followed by the addition of 10 ml of sunflower oil. The mixture was shaken for 5 minutes and then centrifuged at 3000 rpm for 30 minutes. The supernatant was carefully removed and then the tube was reweighed with the residue (18). The oil holding capacity calculates by the equation:

$$\mathbf{OBC} = \frac{\textbf{weight of dry sample} - \textbf{weight of wet sample}}{\textbf{weight of dry sample}}$$

Evaluation of the Functional Properties of Thickening Materials

○ **Emulsion Capacity EC**

According to (18), the sample was accurately weighed and dissolved in 10 ml of distilled water and then 10 ml of sunflower oil was added. The proportions of thickening agents were 0.1, 0.2, 0.4, 0.6, 0.8, 1.0%. Each sample was placed over a magnetic stirrer for 30 min and centrifuged at 1600 rpm for 8 minutes. The emulsion capacity calculates using the following equation.

$$\mathbf{EC} = \frac{\text{winitial emulsion volume}}{\text{total volume}} \times 100$$

○ **Emulsion Stability ES**

Emulsion stability of the extracted materials was determined by heating in a water bath at 80 °C for 30 minutes subjecting all emulsions to centrifugation at 1600 rpm for 8 minutes. Emulsion stability calculates according to the following equation(18):

$$\mathbf{ES} = \frac{\text{total emulsion volumee}}{\text{initial emulsion volume}} \times 100$$

○ **Foaming Capacity FC**

According to the Munir method (18), 50 ml of the extracted thickening solution with distilled water at concentrations of 0.1, 0.2, 0.4, 0.6, 0.8, and 1% (w/v), were placed in a blender and transferred to a graduated cylinder, the volume was noted, and the foam capacity calculates by the following equation:

$$\mathbf{FC} = \frac{\textbf{initial volume \_ final foam volume} \times \mathbf{1000}}{\textbf{initial volume}}$$

○ **Foaming Stability FS**

Foam stability was determined by the method previously described by (18), with minor modifications. 50 ml of thickener solution was mixed with distilled water at concentrations of 0.1, 0.2, 0.4, 0.6, 0.8, and 1% (w/v) in a blender and transferred to a graduated cylinder. The volume was observed after 30 minutes, and foam stability calculates using the following equation:

$$\mathbf{FS} = \frac{\textbf{initial foam volume} - \textbf{final foam volume}}{\textbf{initial foam volume}} \times \mathbf{100}$$

Application of the resulting extracts

The resulting thickening agents were mixed with vegetable soup(wheat flour, noodles, salt, dried vegetables, spices, vegetable oil) at ratios of 1, 2, and 3%, and mixed with Nescafé ready, an instant beverage, at similar concentrations. A taste test then conducted by specialists to evaluate the sensory qualities of taste and aroma.

The Statistical Model used

The nonparametric Wilcoxon test was used to test whether there was a significant difference in the average initial and final volume of both the emulsion and the foam, due to the abnormal distribution of the population from which the study sample was drawn, and the shape of its distribution was tested through the Kolmogorov-Smirnov test.

Results and Discussion

1. The yield of thickening agents in mallow

23 g of thickening agents were obtained in the form of dry powder from about 300 g of dried *Malva parviflora*L., equivalent of 7% of the thickening material powder was obtained by aqueous extraction method. This result was close to the result obtained by (18), which was 6-7.5% of the thickening materials extracted from *M. sylvestris*, and

ISSN 2072-3857

was higer than the grahiys of alcohol, got 0.26 g chilled with the results of Boual and colleagues(19), and returns why some vehicles are lost Alcohol and its absence in the area.

2. Water-Holding Capacity WHC, and Oil-Binding Capacity OBC

For water and oil retention test, the weight of the dry sample was 1 g, and the weight of the wet sample was 7.67 g, 3.17 g respectively. The values of WHC were 6.67 and the values of OBC were 2.17 g/g. WHC value of the powder extractives was approximately 4 g higher compared to the results of others Munir and colleagues (18), which amounted to 2.57 ± 0.60. This increase is likely to be a result of the use of the shoot system of plant, in addition to the nature of the sugars that make up the substances extracted from mallow; whereas the OBC value agreed with the results of Munir and colleagues (18), which amounted to 2.03 ± 0.15. The ability of extractives to bind oil is due to the presence of hydrophobic groups and monopolar molecules that bind oil molecules and prevent the loss of oil and flavor from food systems. The volume of the samples was measured after centrifugation, and the emulsion capacity and stability were calculated at 0.1, 0.2, 0.4, 0.6, 0.8, 1%. The results are shown in tables (1) and (2).

It was observed that the foam capacity and stability increased slightly with increasing concentration, and the emulsion capacity increased similarly with increasing concentration. This is due to the increase in the percentage of phospholipids in the thickeners. These results were consistent with the studies of (18).

3. Results of adding thickeners to Nescafe and conducting a sensory evaluation of the final product

Thickening agents were added to the Nescafe beverage at three graded concentrations: 1%, 2%, and 3%, respectively. The sample was evaluated by 10 expert adults after tasting it for taste and aroma acceptability. The sensory evaluation of the sample at the 1% concentration ranged from 8-10, meaning no difference was observed in the characteristics at this concentration. At the 2% concentration, the evaluation ranged from 5-8, with the taste and aroma of the added agent being acceptable. At the 3% concentration, the taste and aroma of the added agent were very clear, as it affected the sample's sensory characteristics. Table 3 shows the sensory evaluation results.

4. Results of adding thickene rs to vegetable soup and conducting a sensory evaluation of the final product

ISSN 2072-3857

Thickening agents were added to the vegetable soup at three graded concentrations: 1, 2, and 3%, respectively. It was evaluated by 10 adults after tasting them for acceptability of taste, color, and smell. The sensory evaluation of the sample when adding the 1% concentration ranged from 7-9, as the taste and smell changed slightly. As for the color, it became darker, but the sample was acceptable to most people. At the 2% concentration, the evaluation ranged from 4-7, as a large difference was observed in taste and smell, but the color was much darker. At the 3% concentration, the effect on the sensory qualities of the sample was very large, and it was rejected by all people. Table 4 shows the results of the sensory evaluation.

It can be concluded that the use of thickening agents extracted from mallow is possible in the manufacture of some foods at specific concentrations to improve several functional and technical properties, which agrees with Dantas and colleagues (20).

Conclusions and Recommendations

This paper has shown that water extraction gives a higher percentage than alcoholic extraction. Dry thickeners can retain water and oil. Rising concentration increases the ability of thickeners to emulsify. The authors of this study hope to see more work intended to investigate the possibility of further purifying thickening materials, as well as the application of dry thickening materials in food industries. Cultivating the mallow is important for its nutritional and medicinal properties, and does not require extensive expertise or high costs.

Table 1. Emulsion capacity and stability of Thickening Materials

Emulsion Stability	Emulsion Capacity	Concentration %
55 ± 1.6 a	68.9 ± 0.6 a	0.1
70 ± 0.8 b	76.9 ± 1.5 b	0.2
80 ± 1.6 c	83.3 ± 1.5 c	0.4
80 ± 1.6 c	83.3 ± 1.5 c	0.6
90 ± 0.8 d	90.9 ± 1.3 d	0.8
95 ± 1.4 e	95.2 ± 1.6 e	1

Similar letters indicate that there are no significant differences between samples at a confidence level of $p \geq 0.05$.

Table 2. Results of determining the foam capacity and stability of Thickening Materials

Foam capacity	Foam stability	Concentration %
0	0	0.1
96 ± 1.2 a	71.4 ± 0.8 a	0.2
97 ± 1.2 a	78.6 ± 0.9 b	0.4
98 ± 0.5 a	87.5 ± 1.7 c	0.6
98 ± 0.5 a	87.5 ± 1.7 c	0.8
98 ± 1.2 a	90.0 ± 1.3 c	1

Similar letters indicate that there are no significant differences between samples at a confidence level of $p \geq 0.05$.

Table 3. Evaluation of the sensory characteristics of Nescafe beverage after adding thickening agent.

Concentration %	Qualities to be evaluated	Number of tasters									
		1	2	3	4	5	6	7	8	9	10
1	Taste	10	9	8	8	10	8	9	9	10	9
	Smell	10	10	8	9	8	8	9	8	10	8
2	Taste	5	7	6	6	8	5	7	7	8	6
	Smell	6	6	8	5	7	5	8	6	7	8
3	Taste	7	5	4	6	3	3	4	7	5	5
	Smell	3	3	3	4	4	5	4	3	4	4

Table 4. Evaluation of the sensory characteristics of vegetable soup after adding thickening agent.

Concentration %	Qualities to be evaluated	Number of tasters									
		1	2	3	4	5	6	7	8	9	10
1	Taste	9	7	8	9	9	8	9	7	8	9
	Smell	8	7	8	9	8	8	7	9	9	7
2	Taste	5	6	5	4	7	4	6	7	6	4
	Smell	4	5	4	6	5	4	6	7	5	6
3	Taste	2	2	3	4	1	2	2	1	3	4
	Smell	1	2	1	2	1	1	1	2	1	2

CONFLICT OF INTEREST

Regarding the publication of this manuscript, the authors declare that there are no conflicts of interest.

ACKNOWLEDGMENTS

We would like to express our deep gratitude to the staff of the Department of food science, Faculty of Agriculture, University of Damascus, for their help in completing this work.

FUNDING INFORMATION

This research was funded by Damascus University under funding number (50110002059).

References

[1] Elsherif,H.; Elkhoudary, M.; Abdel Salam,R.;Hadad,G.;El-Gindy,A.(

ISSN 2072-3857

2023)A Review of Food Additives from Definition and Types to the Method of Analysis. Records Of Pharmaceutical and Biomedical SCIENCES. Rec. Pharm. Biomed. Sci. 7 (1), 49-64, 2023.

[2] Soukoulis C., Gaiani, C., Hoffmann L. (2018). Plant seed mucilage as emerging biopolymer in food industry applications. *Current Opinion in Food Science*. 2018; *22*, 28-42. https://doi.org/10.1016/j.cofs.2018.01.004.

[3] Singh R., Barreca D. N. (2020). Analysis of gums and mucilages. In Recent Advances in Natural Products Analysis; Silva A. S., Nabavi S. F., Saeedi M., Nabavi S. M., Eds.; Elsevier: Amsterdam, The Netherlands,2020; pp. 663–676. https://doi.org/10.1016/B978-0-12-816455-6.00021-4 .

[4] Khadour S. A., Abou Younes A., Ali Nizam A., (2024). Identify types of chemical compounds of thickening materials extracted from the Malva by FT-IR technology. *Damascus University Journal of Agricultural Sciences*. 2024; 40(4).

[5] Tosif MM. Najda A. Bains A. Kaushik R. Dhull SB. Chawla P. Walasek-Janusz MA(2021). Comprehensive Review on Plant-Derived Mucilage: Characterization, Functional Properties, Applications, and Its Utilization for Nanocarrier Fabrication. Polymers. 2021; 13, 1066. https://doi.org/10.3390/polym13071066.

[6] Naser E. H., Mahdi L., Alasadi R. (2022). Phytochemical constituents and pharmacological activity of *Malva parviflora* plant: A Review. Scientific Journal of Medical Research. V.6 (23), 2022, pp 35-44. *https://www.sjomr.org*.

[7] Oliveira LPD. Bovini MG. Bortoluzzi RLDC. Boff MIC(2019). Boff P. Species of Malva L.(Malvaceae) cultivated in the western of santa Catarina state and conformity with species marketed as medicinal plants in southern Brazil. *Journal of Agricultural Science*. 2019; *11*(15), 171-180. http://dx.doi.org/10.5539/jas.v11n15p171.

[8] Khakpour A. Rezazad Bari M. Pirsa.S. Khakpour F(2024). Preparation of antioxidant and antibacterial film based on mucilage of Panerak flower modified with licorice root and copper sulfate nanoparticles.Iranian journal of food science and industry . 2024; Number 148.

[9] Al-Samarai E. Taies A(2024). The protective effects of L-Carnitine against oxidative toxicity in adult male New Zealand Rabbits. *Tikrit Journal for Agricultural Sciences*. 2024; *24*(3), 1-12. https://doi.org/10.25130/tjas.24.3.1.

[10] Souza G. Siqueira dos Santos S. Bergamasco R. Antigo J. MadronaG. S (2020). Antioxidant activity, extraction and application of psyllium mucilage in chocolate drink. *Nutrition&Food Science*. 2020; *50*(6), 1175-1185. https://doi.org/10.1108/NFS-07-2019-0211

[11] Rashid, F., Ahmed, Z., Hussain, S., Huang, J. Y.,&Ahmad, A. (2019). Linum usitatissimum L. seeds: Flax gum extraction, physicochemical and functional characterization. *Carbohydrate polymers*, *215*, 29-38. https://doi.org/10.1016/j.carbpol.2019.03.054.

[12] Dehghani S. Noshad M. Rastegarzadeh S. Hojjati M,(2024). Fazlara A. Electrospun chia seed mucilage/PVA encapsulated with green cardamonmum essential oils: Antioxidant and antibacterial property. *International Journal of Biological Macromolecules*. 2024; *161*, 1-9. https://doi.org/10.1016/j.ijbiomac.2020.06.023.

[13] Martínez-Hernández G. B., Vargas-Villa G., Jiménez-Ferrer E., García-Aguilar M. P., Zamilpa A., Román-

Ramos R., et al. (2020). Anti-arthritic and anti- inflammatory effects of extract and fractions of Malva parviflora in a mono- arthritis model induced with kaolin/carrageenan. Naunyn Schmiedebergs Arch Pharmacol. 2020;393(7):1281–91.

[14] Sameh S., Elissawy R., Al-Sayed E., Labib R., Chang H-W., Yu S-Y., Chang F-R., Yang S-C., Singab A-N. (2024). Family Malvaceae: a potential source of secondary metabolites with chemopreventive and anticancer activities supported with *in silico* pharmacokinetic and pharmacodynamic profiles. Frontiers in Pharmacology. 28 pp.

[15] Chunarkar-Patil, P., Kaleem, M., Mishra, R., Ray, S., Ahmad, A., Verma, D., et al. (2024). Anticancer drug discovery based on natural products: from computational approaches to clinical studies. Biomedicines 12, 201.doi :10.3390/ biomedicines12010201.

[16] Zhao, J., Yang, J., and Xie, Y. (2019). Improvement strategies for the oral bioavailability of poorly water-soluble flavonoids: an overview. Int. J. Pharm. 570, 118642.doi:10.1016/j.ijpharm.2019.11864.

[17] Afolabi, O., Olasehinde, O., Owolabi, O., Jaiyesimi, K., Adewumi, F., Idowu, O., et al. (2024). Insight into antioxidant-like activity and computational exploration of identified bioactive compounds in Talinum triangular (Jacq.) aqueous extract as potential cholinesterase inhibitors. BMC Complement. Med. Ther. 24, 134. doi:10. 1186/s12906-024-04424-2.

[18] Munir A. Youssef FS. Ishtiaq S. Kamran SH. Sirwi A. Ahmed SA. Elhady SS(2021). Malva parviflora leaves mucilage: An eco-friendly and sustainable biopolymer with antioxidant properties. Polymers. 2021; 13(23),4251.https://doi.org/10.3390/polym 13234251.

[19] Boual, Z., Kemassi, A., Oudjana, A.H., Michaud, P.,& Didi, O. H. M. (2013).Caracterisation partielle des polysaccharide hydrosolubles des feuilles de Malva parviflora .l. (Malvaceae): activite prebiotiqe. Lebanese Science Journal, 14(2), 41-51.

[20] Dantas, T.L.; Alonso Buriti F.C.; Florentino, E.R(2021). Okra(Abelmoschus esculentus L.) as a Potential Functional Food Source of Mucilage and Bioactive Compounds with Technological Applications and Health Benefits. Plants 2021, 10, 1683 https://doi.org/10.3390/ plants10081683.

ISSN 2072-3857