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Extended Abstract

The Mechanical, Rheological and Release Properties of Riboflavin and Biotin Encapsulated Alginate-whey Protein Micro-Gels

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Abstract
Fluid gels already proposed to deliver flavors and nutrients safely. In this paper, our earlier research was applied for mechanical, rheological and release evaluation of the vitamin encapsulated alginate-whey protein microcapsules. The results indicated that the size distribution of alginate-whey protein microcapsules depended on the whey protein concentration, alginate concentration, and emulsification method; the mean diameters of these microcapsules slightly increased as the whey protein and alginate concentration increased. The microcapsules containing riboflavin and biotin showed significant changes in mean diameter volume, but vitamin stability did not change during 30 days at 4 °C. The micro-gels emulsified by ultrasound exhibited a decrease in stiffness than those produced by high-shear blending. The vitamin encapsulated alginate-whey protein microcapsules emulsified by ultrasound were quite stable compared to microcapsule emulsified with the agitator. These micro-gel suspensions exhibit a fluid-like behavior. We founded that the release from these microcapsules mainly occurred by diffusion mechanisms. In summary, this research suggested that alginate-whey protein microcapsules can protect the active and bioactive agent against stomach condition. Our developed vesicular system could be used to nutrient delivery or controlled nutrient release.

Keywords: Controlled Released, Flow Behavior, Micro-Gel, Particle Size, Vitamin B

Introduction
Designing soft, palatable and nutritious texture-modified foods for the elderly is a challenge for food technologists (Aguilera & Park, 2016) . Aging of the world's population occurs at a rapid pace. The elderly are now the fastest growing demographic segment and by 2050 there will be approximately 400 million people aged 80 or more (DESA, 2015). Gel microparticles due to their small size (e.g.<100 mm) and adjustable physical properties are an excellent alternative to tailor the rheological properties of these type of foods (Alicia M Leon, Medina, Park, & Aguilera, 2018). Due to its mechanical and viscoelastic properties, an artificial bolus based on an alginate gel has been proposed to evaluate the swallowing of patients with dysphagia, and the design of optimal menus (Alicia Magaly Leon, Aguilera, & Park, 2019). Gel microparticles appear to be potentially useful as oral delivery vehicles for bioactive compounds in the food and nutraceuticals industry as well as nonfood industry (Chen & Subirade, 2006). Nanoemulsion is a potential tool to enhance the stability and bioavailability and also controlled release of bioactive compounds under the desired conditions (Mohsen Zandi & Mohebbei, 2014). Food-grade gel microparticles are small-sized gels usually formed

by proteins or polysaccharides and their combinations. They are finding increasing application in foods due to their unique physicochemical characteristics and functional attributes (Aguilera & Park, 2016). Proteins and polysaccharides are natural polymers that are used as carriers and determinants of the release rate in controlled release systems Recently, whey protein- sodium alginate (WP/SA) compound has been candidate for targeted release system (Abbasi, Samadi, Jafari, Ramezanpour, & Shams Shargh, 2019). B group vitamins are a group of important compounds for the development and normal growth of living beings, thus their absence is the cause of various serious physical and physiological problems (Beck, 2001; Combs Jr, 2008). The aim of the present research was investigated mechanical, rheological and release of the vitamin encapsulated alginate-whey protein microcapsules fabricated in our earlier work (Zandi, 2019).

Materials and methods

AL-WPC Micro gel Preparation and Characterization

In this research, the vitamin encapsulated AL-WPC microcapsule fabrication was accomplished via Zandi (2019) technique (Zandi, 2019; Zandi, Mohebbei, Varidi, & Ramezanian, 2015). For AL-WPC microsphere characterization, microsphere sizing were accomplished by using a dynamic light scattering (Nano- Zeta sizer, Japan).

Mechanical and rheological properties of bulk emulsion gels

Cylindrical samples (10 mm height-20 mm diameter) of bulk emulsion gels were subjected to uniaxial compression in a texture analyzer, to acquire stress-deformation curves and determine the maximum compressive stress. Rheological properties of AL-WPC Micro gels were studied by using a Physica rheometer (model MSR301, Astoria) with a 20 mm diameter parallel plate geometry and a 0.5 mm gap.

Diffusion coefficient calculation

It was found that release from these microcapsules followed a classical Fickian diffusion. Diffusion coefficient was calculated for each condition by using AL-WPC Micro gel experimental data; therefore, we solved diffusion equation, and resulted equation was fitted to the experimental release data.

Statistical Analysis

Data were also analyzed by analysis of variance (ANOVA) using the Design Expert 9.0 software and graphs' error bars were obtained. All experiments were obtained from at least triplicate measurement (Table 1).

Table 1. ANOVA result

	SS	df	MS	F Value	p-value
Model	2058.50	7	294.07	18.00	< 0.0001
A-Emulsification Method	1441.50	1	1441.50	88.26	< 0.0001
B-Whey protein	73.50	1	73.50	4.50	0.0499
C-Alginat	204.17	1	204.17	12.50	0.0027
AB	73.50	1	73.50	4.50	0.0499
AC	88.17	1	88.17	5.40	0.0337
BC	140.17	1	140.17	8.58	0.0098
ABC	37.50	1	37.50	2.30	0.1492
Pure Error	261.33	16	16.33		
Cor Total	2319.83	23			

Results and discussion

The results indicated that the size distribution of alginate-whey protein microcapsules depended on the whey protein concentration, alginate concentration, and emulsification method; the mean diameters of these microcapsules slightly increased as the whey protein and alginate concentration increased. The microcapsules containing riboflavin and biotin showed significant changes in mean diameter volume, but vitamin stability did not change during 30 days at 4 °C. The micro-gels emulsified by ultrasound exhibited a decrease in stiffness than those produced by high-shear blending. The vitamin encapsulated alginate-whey protein microcapsules emulsified by ultrasound were quite stable compared to microcapsule emulsified with the agitator. These micro-gel suspensions exhibit a fluid-like behavior. We founded that the release from these microcapsules mainly occurred by diffusion mechanisms (Figs. 1 and 2).

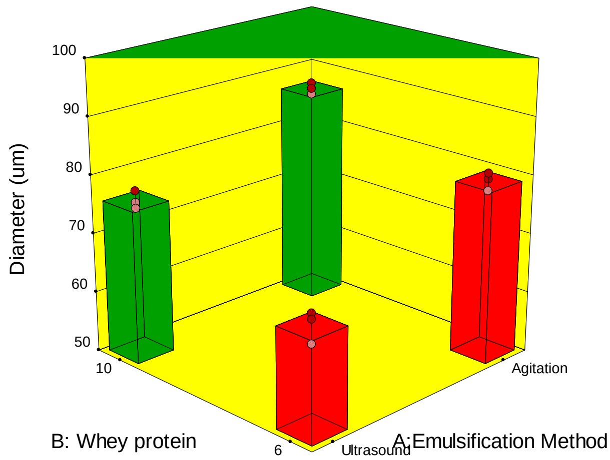

Fig. 1. The effect of emulsification method and whey protein on the microcapsule size

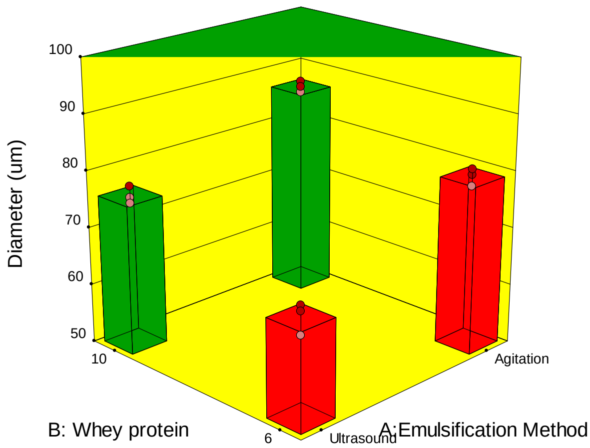

Fig. 2. The effect of emulsification method and Alginate on the microcapsule size

Conclusions

Designing soft, palatable and nutritious texture-modified foods for the elderly is a challenge for food technologists. Formulated microcapsules had mechanical and rheological properties in the range of soft foods recommended for the elderly. The vitamin encapsulated alginate-whey protein microcapsules emulsified by ultrasound were quite stable compared to microcapsule emulsified with the agitator. In summary, this research suggested that alginate-whey protein microcapsules can protect the active and bioactive agent against stomach condition. Our developed vesicular system could use nutrient delivery or controlled nutrient release. Further work should include the effect of formulation on mechanical and rheological properties and a precise characterization of the structural features of AL-WPC Micro gel.

References

Abbasi, F., Samadi, F., Jafari, S. M., Ramezanpour, S., & Shams Shargh, M. (2019). Ultrasound-assisted preparation of flaxseed oil nanoemulsions coated with alginate-whey protein for targeted delivery of omega-3 fatty acids into the lower sections of gastrointestinal tract to enrich broiler meat. *Ultrasonics Sonochemistry*, *50*, 208-217. doi:https://doi.org/10.1016/j.ultsonch.2018.09.014

Aguilera, J. M., & Park, D. J. (2016). Texture-modified foods for the elderly: Status, technology and opportunities. *Trends in Food Science & Technology*, *57*, 156-164. doi:https://doi.org/10.1016/j.tifs.2016.10.001

Beck, W. (2001). Handbook of Vitamins, ; Rucker, RB, Suttie, JW, McCormick, DB, Machlin, LJ, Eds. In: Marcel Dekker: New York.

Chen, L., & Subirade, M. (2006). Alginate–whey protein granular microspheres as oral delivery vehicles for bioactive compounds. *Biomaterials*, *27*(26), 4646-4654. doi:https://doi.org/10.1016/j.biomaterials.2006.04.037

Combs Jr, F. (2008). Vitamin C. In The vitamins. Fundamental aspects in nutrition and health/FG Jr. Combs. (Third edition ed.). In (pp. 235-265): Amsterdam Boston: Elsevier Aca demic Press.

DESA, U. (2015). World population prospects: the 2015 revision, key findings and advance tables. United Nations Department of Economic and Social Affairs. *Population Division working paper no ESA/P/WP, 241*.

Leon, A. M., Aguilera, J. M., & Park, D. J. (2019). Mechanical, rheological and structural properties of fiber-containing microgels based on whey protein and alginate. *Carbohydrate polymers*, *207*, 571-579. doi:https://doi.org/10.1016/j.carbpol.2018.11.094

Leon, A. M., Medina, W. T., Park, D. J., & Aguilera, J. M. (2018). Properties of microparticles from a whey protein isolate/alginate emulsion gel. *Food science and technology international*, *24*(5), 414-423. doi:https://doi.org/10.1177/1082013218762210

Zandi, M. (2019). Vitamin protection by Alginate-Whey Protein Micro Gel (AL-WPC MG) as a novel microcapsule against gastrointestinal condition; case study: B-complex vitamins. *Iranian Food Science and Technology Research Journal*, in press. doi:https://doi.org/10.22067/ifstrj.v16i3.79215

Zandi, M., & Mohebbei, M. (2014). Investigation of encapsulated diacetyl colloidosome release profile as a function of sintering process and release media properties. *Flavour and fragrance journal*, *29*(6), 364-370. doi:https://doi.org/10.1002/ffj.3214

Zandi, M., Mohebbei, M., Varidi, M., & Ramezanian, N. (2015). Estimation and evaluation of diffusion coefficient of diacetyl encapsulated alginate-whey protein microspheres at simulated mouth conditions. *Iranian Food Science and Technology Research Journal*, *11*(4), 435-444. doi:https://doi.org/10.22067/ifstrj.v1394i11.29045 (in Persian)