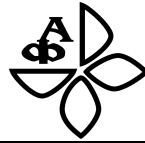




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XXVII SAVETOVANJE O BIOTEHNOLOGIJI

sa međunarodnim učešćem

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PREDGOVOR

Poljoprivreda je primarna i strateška delatnost koja obezbeđuje prehrambenu sigurnost, stabilnost tržišta hrane i štiti životni standard stanovništva. Svedoci smo da je u kriznim situacijama u zemlji poljoprivreda odgovorila svom zadatku i bila glavni oslonac u snabdevanju tržišta prehrambenim proizvodima. Proizvodnjom dovoljnih količina zdravstveno bezbedne hrane omogućava se razvoj radno sposobnog stanovništva koje aktivno učestvuje u ekonomskom razvoju društva. Specifični uslovi u kojima se poljoprivreda razvija zahtevaju konkretne ekonomske mere podrške i subvencije države za očuvanje domaće poljoprivrede. Planiranim investicijama u poljoprivredi uvođenjem savremene tehnologije i efikasne organizacije u proizvodnji i prometu smanjuju se ekonomski i tržišni rizici, a samim tim omogućavaju stabilni uslovi poslovanja. Razvoj poljoprivrede se mora bazirati na multifunkcionalnom povezivanju sa ostalim delatnostima (prehrambenom industrijom, trgovinom, turizmom i td.)

Poljoprivredna nauka i struka prati i proučava promene koje se dešavaju u ovoj oblasti ukazuje na aktuelne probleme poljoprivredne prakse i pronalazi rešenja. Agronomski fakultet u Čačku, pored edukacije studenata, svake godine tradicionalno već dvadeset sedmi put, organizuje i Savetovanje o biotehnologiji. Osnovni cilj Savetovanja je upoznavanje šire naučne i stručne javnosti sa rezultatima najnovijih naučnih istraživanja, domaćih i inostranih naučnika iz oblasti osnovne poljoprivredne proizvodnje i prerade hrane, kao i zaštite životne sredine.

U Zborniku radova XXVII Savetovanja o biotehnologiji sa međunarodnim učešćem, predstavljeno je ukupno 84 rada iz oblasti Ratarstva, povrtarstva i krmnog bilja, Voćarstva i vinogradarstva, Zootehnike, Zaštite bilja, proizvoda i životne sredine i Prehrambene tehnologije.

Ministarstvu prosvete, nauke i tehnološkog razvoja Republike Srbije i Gradu Čačku kao glavnim pokroviteljima dugujemo veliku zahvalnost što su pomogli kao i svake godine da se ovo Savetovanje održi. Zahvaljujemo privrednicima i svim dugogodišnjim prijateljima Agronomskog fakulteta što su nam pružili materijalnu i organizacionu podršku.

Bavljenje poljoprivredom pored ekonomije i biznisa je i socijalna plemenita delatnost, s obzirom da zadovoljava osnovnu nasušnu potrebu ljudi za hranom. Poljoprivredni proizvođači zaslužuju ugled i poštovanje u društvu i treba im omogućiti da pristojno žive od svoga rada, a društvo bi to trebalo da prepozna.

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CHARACTERISTICS OF OCTADECYLAMINE-STABILIZED LIPOSOMES CONTAINING SOY PROTEIN HYDROLYSATES

Neda Pavlović¹, Jelena Mijalković², Verica Đorđević², Branko Bugarski², Zorica Knežević Jugović²

Abstract: Liposomes have been researched as carriers for encapsulation of bioactive protein hydrolysate, despite low stability which makes them difficult to use. Using cholesterol or octadecylamine as lipid membrane stabilizers, soy protein hydrolysate is effectively encapsulated in liposomes created with phospholipon. Presence of both stabilizers concurrently resulted the highest efficiency 49.7%, while increasing the phospholipon mass had no effect. Particle size was raised (265 to 335 nm) as a result of the octadecylamine addition, and zeta potential was positive (36.7 mV), as compared to the cholesterol addition (-25.1 mV). Liposomes enabled extended hydrolysate release with retained its bioactivity.

Key words: soy protein hydrolysate, liposomes, octadecylamine, antioxidant activity, controlled release

Introduction

Liposomes are one of the most studied carriers for encapsulating bioactive protein hydrolysates and peptides. Because of their structure, they can encapsulate both hydrophilic and hydrophobic molecules, and they also exhibit a number of advantages, such as biodegradability, low toxicity, and the possibility of surface modification due to prolonged protein release (Mohan, et al., 2015). Due to their poor stability, liposomes are not used commercially due to oxidation and hydrolysis of lipids, cleavage and fusion of colloidal particles, and loss of hydrophilic core. Mentioned drawbacks are addressed by the addition of stabilizers such as cholesterol, octadecylamine, oleic acid, and others (Nkanga et al., 2019).

Soy peptides are widely used in the food industry for their antioxidant properties, and can also be found in creams that improve skin elasticity and help stimulate collagen production in the pharmaceutical industry (Yoshihiro et al., 2012). Additionally, soy peptides have a number of disadvantages that limit their use, including: reduced digestibility, potential allergenicity, bitter taste, and instability and degradation when incorporated into food products (Mohan, et al., 2015). Bioactive peptides in commercial products are often susceptible to digestion by digestive enzymes, resulting in their biological inaction. Therefore, the main goal of this research was to encapsulate the soy protein hydrolysates riched of the bioactive peptides in liposomes carriers in order to increase stability and

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bioavailability of hydrolysates. The effect of cholesterol and/or octadecylamine as membrane stabilizers on the encapsulation parameters and antioxidant activity as well as on the encapsulated peptide release have been examined.

Materials and methods

Enzymatic hydrolysis of a soy protein concentrate (Sojaprotein A.D., Serbia) was performed as a two-step biotechnological process using Neutrase® and Flavourzyme® (Sigma Aldrich, USA) in a batch reactor previously described by Pavlović et al. (2020). After 3 h, the enzymes were inactivated. Then, the mixture was centrifuged 10 min at 10000xg. The soy protein hydrolysate was collected and dried in a spray dryer.

The liposomes were prepared by the thin film method (Pavlović et al., 2020). After the complete dissolution of 0.18 or 0.45 g phospholipon (Phospholipon 90G, Natterman Phospholipids, Germany) in a round bottom flask, cholesterol (Ph:Ch ratio was 9:1), Tween 80 (0.010 cm³), and soy protein hydrolysate (20 mg) were added. Another samples were prepared with octadecylamine addition (Ph:Ch:Oc ratio was 9:1:1). Chloroform was evaporated by vacuum evaporator at a temperature of 50 °C and pressure of 343 mbar. The created thin film was hydrated with Tris-HCl buffer (0.01 M; pH 7) preheated at 60 °C. Five cycles of heat and cool treatment are performed with duration of 2 min per cycle. Then, the liposome suspensions were sonicated (Sonopuls Ultrasonic Homogenizers, Bandelin, Germany) with frequency of 20 kHz and amplitude 30%, in the three cycles. Every cycle consists of 20 s sonication and 1 min of cooling. Liposome suspension was centrifuged at 40000 rpm 30 min at 4 °C (Optima™ L-100 XP ultracentrifuge, Beckman Coulter, California), and the supernatant is decanted. **Encapsulation efficiency** was calculated as the ratio of the encapsulated peptides mass and the mass of the total peptides, which are determined by measuring the concentration of the non-encapsulated peptides by modified Lowry method (Hartree, 1972).

The prepared liposome suspension are characterized by **average particle size, particle size distribution, polydisperse index (PDI) and zeta potential** using the apparatus based on principles of photon-correlated spectroscopy (Zetasizer Nano Series, NanoZS, Malvern Instruments Ltd., UK).

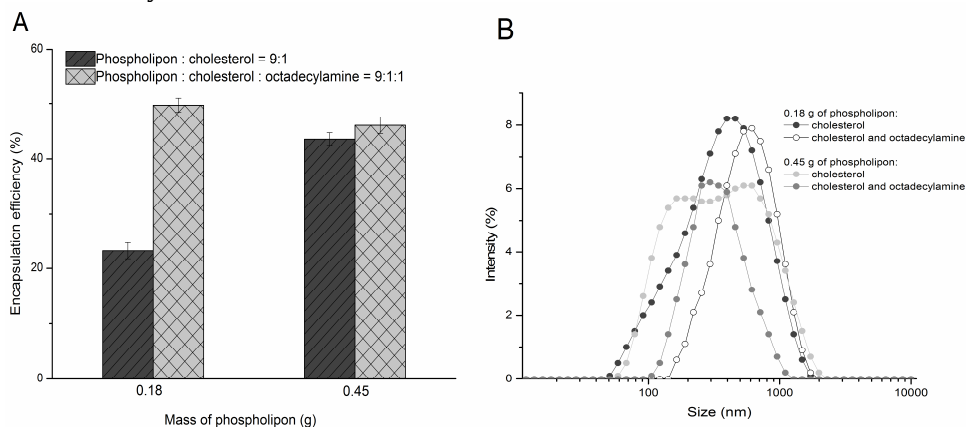
Antioxidant activity of the encapsulated soy protein hydrolysate was determined by measuring the inhibition rate of ABTS^{•+} radical cation. The reduction capacity of ABTS^{•+} radical cation is determined as previously described (Pavlović et al., 2020). Briefly, the diluted radical cation ABTS^{•+} (1.0 cm³) was mixed with sample (0.010 cm³) and after 5 min the absorbance was measured.

In vitro digestion catalyzed by pepsin (gastric juice) and pancreatin (pancreatic juice) is performed by previously described method (Gomaa et al., 2017). The digestion is performed by mixing of liposome suspensions and corresponding juice (volume ratio was 1:3) at a temperature of 37 °C and 140 rpm. **The controlled release** of encapsulated hydrolysate is assessed using Franz cell consisting of cellulose-acetate membrane. 2 cm³ of the prepared liposome

suspension is placed in the donor section of the Franz cell, while in the acceptor section Tris-HCl buffer (0.01 M, pH 7) is placed. In both release studies, the percentage of diffused/released peptides is determined as a ratio of the peptide mass during digestion and the mass of the encapsulated peptides.

Results and Discussion

In order to optimize the process parameters, the mass of phospholipon mass was varied, and the influence of cholesterol and octadecylamine addition on the encapsulation efficiency was analyzed. The obtained results presented in the Fig. 1A. In the samples with cholesterol a change in efficiency was observed in correlation with the mass of phospholipon, while in samples with octadecylamine this difference is negligible. Liposomes created with cholesterol as stabilizer, the increase of phospholipon mass from 0.18 to 0.45 g, led to the increase of encapsulation efficiency from 23.3 to 43.6 %. This can be attributed to the increase of available surface for encapsulation of soy hydrolysate, by increasing the phospholipid mass (Mohan, et al., 2015). For the samples contained with cholesterol and octadecylamine, it can be observed that the increase of phospholipon mass does not affect the encapsulation efficiency. The values for encapsulation efficiency of 49.7 and 46.1% for 0.18 and 0.45 g of phospholipon, respectively, were not statistically significant. This means that the addition of octadecylamine has a positive effect on the stability of liposome membrane and has increased the encapsulation efficiency remarkably in coparation with liposome conssted only with cholesterol.



Graph. 1. Encapsulation efficiency of soy protein hydrolysate (A) and particle size distribution of liposome with soy protein hydrolysate (B)

Graf. 1. Efikasnost inkapsulacije proteinskog hidrolizata soje (A) i raspodela veličine čestica sa proteinskim hidrolizatom soje

On the Fig. 1B, the distribution of the average particle size of created liposomes was presented. Average particle size, PDI values, and zeta potential of the obtained

liposomal suspensions are given in the Table 1. Observing the distribution curves of liposomes with cholesterol, it can be seen that the samples with low mass of phospholipon (0.18 g) have the unimodal distribution when compared with the samples prepared by use 0.45 g of phospholipon with multimodal distribution. The above is also confirmed by the value of PDI; 0,514 for multimodal distribution (Table 1). The wide distribution of liposomes with high phospholipon can be due to the fact that the more concentrated liposome suspensions are more resistant to sonication effect (i.e. deformation) used as a method to reduce the size of the liposome and obtain SUV (small unilameral vesicles) from MLV (multilamellar vesicles). Besides, it can be emphasized that the addition of octadecylamine contributed to a more uniform distribution in both cases 0.18 and 0.45 g of phospholipon, which was resulted in low PDI index value (0.339 and 0.382, respectively). In summary, it can be pointed out that the addition of octadecylamine increased the particle size, which is in correspondance with the previous letarature data (Mattheolabakis et al., 2012).

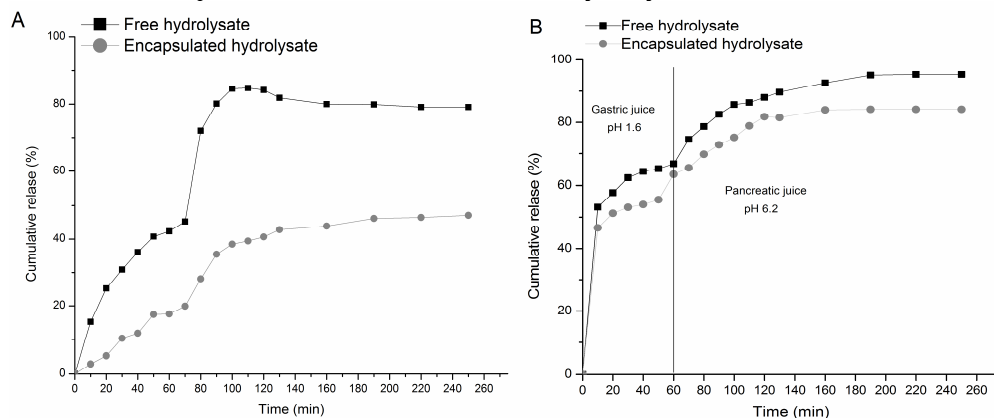
The zeta potential is commonly considered as a measure of liposomal suspension stability. Because of their low electrostatic repulsion, the particles will aggregate if its value is close to zero. The liposome vesicles are considered stable when the zeta potential is higher than 35 mV or lower than -35 mV (Mohan, et al., 2015). From Table 1, it can be concluded that the liposomes with soy hydrolysate are very stable, and that the liposomes with cholesterol have negative net surface charge, but the ones with octadecylamine have positive net surface charge.

Table 1. Characterization of liposomes with soy protein hydrolysate
Tabela 1. Karakterizacija lipozoma sa proteinskim hidrolizatom soje

Liposome <i>Lipozomi</i>	0.18 g of phopsholipon <i>0,18 g fosfolipona</i>		0.45 g of phopsholipon <i>0,45 g fosfolipona</i>	
	Ph:Ch = 9:1	Ph:Ch:Oc = 9:1:1	Ph:Ch = 9:1	Ph:Ch:Oc = 9:1:1
Average size (nm) <i>Sr. veličina čestica (nm)</i>	289.9	331.8	265.8	334.7
Polydispersity index <i>Polidisperzni indeks</i>	0.395	0.339	0.514	0.382
ABTS activity (%) <i>ABTS aktivnost (%)</i>	22.22	43.24	41.81	41.95
Zeta potential (mV) <i>Zeta potencijal (mV)</i>	-25.10	36.70	-29.40	40.70

When the influence of phospholipon concentration on ABTS scavenging activity is examined (Table 1), it can be shown that the conserved ABTS activity is consistent with the achieved encapsulation efficiency. As the encapsulation efficiency increases, an increase in ABTS activity is observed. From the results of ABTS activity, it can be concluded that the antioxidant activity originates from the encapsulated soy peptides generated in hydrolysate. Presented results are in agreement with the results reported by Bertolini et al. (2001).

Finally, the hydrolysate controlled released studies from liposome was performed. Taking into consideration the determined values of the zeta potential, the liposome created with cholesterol and octadecylamine are examined in a Franz diffusion cell (Fig. 3A), which is used as a model system for imitation of skin cells, and liposome created with cholesterol are analyzed using *in vitro* gastrointestinal simulation system (Fig. 3B). From Fig. 3A, it can be noted that the liposome provide extended release of the hydrolysate, i.e. through the membrane were released 80% of free hydrolysate, while from liposomes almost 47%. Observing Fig. 3B, it can be pointed out that the total amount of free hydrolysate was diffused, while from the liposomes the released amount of hydrolysates was 84%.



Graph. 2. Controlled release of soy protein hydrolysate: (A) Franz cell and (B) *in vitro* gastrointestinal simulation system

Graf. 2. Kontrolisano otpuštanje proteinskog hidrolizata soje: (A) Francova ćelija i (B) *in vitro* sistem sa simulacijom gastrintestinal uslova

Conclusions

In this study, the liposomes was created by the thin film method using commercial mixture of phospholipon with addition of stabilizing agents: cholesterol and octadecylamine. The best satisfactory encapsulation efficiency and retained ABTS scavenging activity were obtained for liposome vesicles created with cholesterol, and concurrently cholesterol and octadecylamine, in both cases when used 0.45 g of phospholipon. Liposome characterization study confirmed that they are stable particles, in both cases, suitable for encapsulation of soy hydrolysate. Created liposomes formulation with antioxidant soy hydrolysate can be used as: a) dietary functional food supplement (liposome with cholesterol), and b) cosmetic formulations (liposome with cholesterol and octadecylamine).

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References

- Bertolini, A.C., Siani, A.C., Grosso, C.R.F. (2001). Stability of Monoterpenes Encapsulated in Gum Arabic by Spray-Drying. *Journal of Agricultural and Food Chemistry*. 49: 780-785.
- Gomaa, A. I., Martinent, C., Hammami, R., Fliss, I., Subirade, M. (2017). Dual Coating of Liposomes as Encapsulating Matrix of Antimicrobial Peptides: Development and Characterization. *Frontiers in Chemistry*. 5:103.
- Hartree E. F. (1972). Determination of protein: A modification of the Lowry method that gives a linear photometric response, *Analytical Biochemistry*. 48:422-427.
- Mattheolabakis G., Nie, T., Constantinides, P. P., Rigas, B. (2011). Sterically Stabilized Liposomes Incorporating the Novel Anticancer Agent Phospho-Ibuprofen (MDC-917): Preparation, Characterization, and In Vitro/In Vivo Evaluation. *Pharmaceutical Research*, 29(6):1435-1443.
- Mohan, A., Rajendran, S. R., He, Q. S., Bazinet, L., Udenigwe, C. C. (2015). Encapsulation of food protein hydrolysates and peptides: a review. *RSC advance*. 5(97):79270-79278.
- Nkanga, C. I., Bapolisi, A. M., Okafor, N. I., Krause, R. W. M. (2019). General perception of liposomes: formation, manufacturing and applications. In A. Catala (ed.), *Liposomes - Advances and Perspectives*. IntechOpen. London.
- Pavlović N., Jovanović J., Đorđević V., Balanč B., Bugarski B., Knežević-Jugović Z. (2020). Production and characterization of liposomes with encapsulated bioactive soy protein hydrolysate. *Chemical Industry*. 74(5):327-339.
- Tokudome, Y., Nakamura, K., Kage, M., Todo, H., Sugibayashi, K., Hashimoto, F. (2012). Effects of soybean peptide and collagen peptide on collagen synthesis in normal human dermal fibroblasts. *International journal of food sciences and nutrition*. 63(6): 689-695.

KARAKTERISTIKE LIPOZOMA STABILIZOVANIH OKTADECILAMINOM SA INKAPSULISANIM HIDROLIZATOM PROTEINA SOJE

*Neda Pavlović¹, Jelena Mijalković², Verica Đorđević², Branko Bugarski²,
Zorica Knežević Jugović²*

Izvod

Lipozomi su dugo proučavani nosači za inkapsulaciju bioaktivnih proteinskih hidrolizata, uprkos niskoj stabilnosti koja predstavlja problem za širu primenu. Koristeći stabilizatore holesterol i oktadecilamin, proteinski hidrolizat soje je uspešno inkapsuliran u lipozome sačinjene od fosfolipona. Prisustvo oba stabilizatora istovremeno rezultiralo je najvećom efikasnošću 49,7 %, dok povećanje početne mase fosfolipona nije imalo uticaja na efikasnost. Veličina lipozoma je povećana (sa 265 na 335 nm) kao rezultata dodavanja oktadecilamina, ali je zeta potencijal pozitivan (36,7 mV) u poređenju sa dodatkom holesterola (-25,1 mV). Pripremljeni lipozomi omogućili su produženo oslobađanje hidrolizata soje uz očuvanje njegove bioaktivnosti.

Ključne reči: proteinski hidrolizat soje, lipozomi, oktadecilamin, antioksidativna aktivnost, kontrolisano oslobađanje

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