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EVALUATION OF FREEZE-DRIED SURIMI FROM TILAPIA AND FAT SLEEPER AS EMULSIFIERS

EVALUACIÓN DE SURIMI LIOFILIZADO DE TILAPIA Y DORMIDOR COMO EMULSIFICANTES

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Abstract

Surimi is mainly used as a structural ingredient in the formulation of seafood analogs. Additionally, freeze-dried surimi may be employed as an emulsifying agent in sausage products. The objective of this work was to evaluate the emulsifying capacity of the freeze-dried surimi in a 50:50 water:oil model emulsion system. Freeze-dried surimi was obtained from fat sleeper *(Dormitator maculatus)* and tilapia *(Orochromis nilotica)*. Surimi was added at the levels of 0.1, 0.3 or 0.5 %, and emulsions were formed at 15°C, 25°C or 35°C. The drainage kinetic ratio was calculated. The highest emulsion stability was obtained performing at the highest level of surimi concentration and the highest temperature. Freeze-dried surimi from fat sleeper had better emulsification properties than tilapia surimi, obtaining a good emulsion stability included using the lowest temperature. Both products have potential as ingredient in meat emulsions. Results obtained in this work show that surimi proteins can be used as a functional ingredient capable to stabilize emulsions.

Keywords: Surimi, emulsifiers, emulsion stability.

Resumen

El surimi se usa principalmente como un ingrediente estructural en la formulación de análogos de mariscos. Adicionalmente, se puede utilizar el surimi liofilizado como un agente emulsificante de productos de charcutería. El objetivo de este trabajo fue evaluar la capacidad emulsificante de surimi liofilizado en un sistema modelo de emulsión (50:50) aceite:agua. Se obtuvo surimi liofilizado de dormidor *(Dormitator maculatus)* y "tilapia" *(Orochromis nilotica)*. Se adicionó surimi en concentraciones de 0.1, 0.3 y 0.5% y se emulsificó a temperaturas de 15ºC, 25ºC y 35ºC. Se calcularon las cinéticas de drenaje. La emulsión más estable se obtuvo trabajando con la concentración más alta de surimi y emulsionando a la mayor temperatura estudiada. Surimi liofilizado de dormidor tuvo mejores propiedades emulsificantes que él de tilapia, obteniéndose una buena estabilidad de la emulsión incluso emulsionando a bajas temperaturas. Ambos productos pueden usarse como ingredientes en la formulación e emulsiones cárnicas. Los resultados obtenidos en este trabajo muestran que las proteinas del surimi pueden usarse como aditivos para estabilizar emulsiones.

Palabras clave: Surimi, emulsionantes, estabilidad de emulsiones.

Resumo

O surimi úsase principalmente como un ingrediente estructural na formulación de análogos de mariscos. Adicionalmente, pódese utiliza-lo surimi liofilizado como un axente emulsificante de productos de charcutería. O obxetivo de este traballo foi evalua-la capacidade emulsificante de surimi liofilizado nun sistema modelo de emulsión (50:50) aceite:auga. Obtívose surimi liofilizado de dormidor *(Dormitator maculatus)* e "tilapia" *(Orochromis nilotica)*. Adicionouse surimi en concentracións de 0.1, 0.3 e 0.5% y emulsificouse a temperaturas de 15ºC, 25ºC e 35ºC. Calculáronse as cinéticas de drenaje. A emulsión mais estable obtívose traballando coa concentración mais alta de surimi e emulsionando á maior temperatura estudiada. Surimi liofilizado de dormidor tivo mellores propiedades emulsificantes co de tilapia, obténdose unha boa estabilidade da emulsión incluso emulsionando a baixas temperaturas. Ámbo-los dous productos poden usarse como ingredientes na formulación e emulsións cárnicas. Os resultados obtidos neste traballo mostran cas proteínas do surimi poden usarse como aditivos para estabilizar emulsións.

Palabras chave: Surimi, emulsionantes, estabilidade de emulsións.

INTRODUCTION

Surimi is a high quality myofibrillar protein concentrate, obtained from fish muscle. One of its major properties is forming strong and elastic gels through thermal treatment (Lee and Park, 1998). Several food applications for surimi proteins are known. This is because surimi proteins have better binding, gelling and emulsifying properties than plant proteins currently used in the meat industry (e.g. soy).

However, the current handling of surimi as a frozen block is a handicap for its utilization as an ingredient in food applications. Freeze-drying process does not damage the functionality of myofibrillar proteins (Montejano *et al.*, 1994; Suzuki *et al.*, 1992). Therefore freeze-dried surimi presents a more versatile structure to increase its application possibilities. Freeze-dried surimi is a commercial product in Japan. It is used as binder, dispersing agent and emulsifier in re-structured products made out of beef, pork and chicken meat. Also it is applied for formulation of exotic dishes.

Several studies describe the preparation of powdered surimi from low commercial value species available in Mexico. These studies include only adsorption processes and rheological characteristics (Azuara *et al.*, 1992; Díaz-Sobac *et al.*, 1995; Montejano *et al.*, 1994). However, other functional properties have not been investigated.

The purpose of the present work was to assess the stability properties of emulsions in a model oil:water system prepared with addition of freeze-dried surimi from fat sleeper *(Dormitator maculatus)* or tilapia *(Orochromis nilotica)*. Tilapia is a suitable raw material for surimi processing (Onibala *et al.*, 1997). No reports about surimi from fat sleeper were found in the literature. Both fish species have low commercial value and high availability in fresh water bodies throughout the year. The effect of surimi concentration and temperature of mixing on emulsion stability were evaluated.

MATERIALS AND METHODS

Surimi preparation

Fresh tilapia *(Orochromis nilotica)* and fat sleeper *(Dormitator maculatus*) were obtained from a fish market in Tampico, Tamaulipas, Mexico. Fishes were headed, gutted and washed. Skin and bones were removed with a Bibun deboning machine (Model NF2DX, Hiroshima, Japan) with a drum having 5 mm diameter perforations. Minced muscle was mixed with water at a ratio 1:3 (w/w) and stirred for 10 min. Then held without stirring for 5 min at 10°C. Excess water was removed with a hand press. Surimi was mixed with 8% sucrose using a Hobart mixer (model VCM. Troy, Ohio). Surimi was packed into polyethylene bags (2 kg each one), fast frozen during 5 h at –30 °C in a Crepaco plate freezer (Model B-5854-AM12, Crepaco, Inc., Chicago, IL) and stored at –20°C until needed.

Freeze-drying

Frozen surimi samples were cut in blocks of 8 cm^3 and placed into glass bottles at -20 ^{0}C, which were attached to a Lyph-Lock Labconco laboratory freeze drier (Labconco® Corp. Kansas City, Missouri, USA). Freeze dry was performed at a condenser temperature of -50 ^{0}C. The dehydrated product was milled and passed through a 60-80 mesh and the powdered samples were kept in thermosealable plastic bags until used.

Proximate Analysis

Fresh and freeze-dried surimi samples were analyzed for moisture, protein, fat and carbohydrate content, according to official methods (AOAC 1980).

Emulsion preparation

A model system consisting of 50 mL water/corn oil (1:1, v/v) was used to test the ability of surimi proteins to stabilize emulsions. Freeze-dried surimi was added at levels of 0.1, 0.3 or 0.5% and mixed for 8 minutes. Emulsions were prepared at 15, 25 or 35 ^{0}C in order to study the effect of mixing temperature on emulsion stability. Preliminary runs aided in determining that drinking water at pH 6.9 and a stirring time of 8 minutes were adequate conditions to prepare emulsions with the model system described above.

Emulsion stability

Stability of emulsions was evaluated by measuring the rate of creaming of 50 mL of emulsion during 24 hours at 45°C. Creaming rate is represented by the drainage ratio calculated as:

$$DR = \frac{V_t}{V_o} \cdot 100$$

where, V_t= drained volume and V_0= initial volume (Chung and Ferrier, 1992).

Statistical analysis

All determinations were run in quadruplicate and results were analyzed by ANOVA. A Duncan paired test was used to test for significance between variables. All analyses were made using the statistical package Minitab 8.2.

RESULTS AND DISCUSSION

Results from the proximate analysis of fresh and freeze-dried surimi samples from tilapia *(Orochromis nilotica)* and fat sleeper *(Dormitator maculatus)* are presented in Table 1. Surimi from both fish species presented a high protein contents (62 -65%) in the freeze-dried samples. The main difference in dry basis is the presence of sucrose in the freeze-dried surimi, which is added as a cryoprotectant in order to avoid undesirable and irreversible protein interactions during freezing.

Table 1.- Proximate composition of frozen and freeze-dried surimi of tilapia *(Orochromis nilotica)* and fat sleeper *(Dormitator maculatus)*.

	TILAPIA		FAT SLEEPER	
	Frozen surimi	Freeze-dried surimi	Frozen surimi	Freeze-dried surimi
Moisture, %	78	4.6	75	4.2
Protein, %	15.1	62	18.1	64.7
Fat, %	0.48	2.9	0.57	3.6
Ash, %	0.42	1.60	0.35	1.32
Carbohydrates, %		8		8

Freeze-dried surimi is a concentrate of myofibrillar proteins, where myosin and actin are the most abundant proteins forming the actomyosin complex. Both, myosin and actomyosin are emulsifiers when are placed in an oil:water interface (Dominics and Wong, 1990).

The stability of the water/oil emulsions obtained by adding 0.1, 0.3 or 0.5% of freeze-dried surimi powder from tilapia at different emulsification temperatures is showed in Figure 1. It is possible to observe that increases on temperature of emulsification produced lower drainage ratios, allowing higher stability. This effect was stronger for the low level of surimi added (Figure 1a). At high levels of surimi added little differences on the creaming rate was obtained (Figure 1c). Therefore an interaction between emulsification temperature and surimi added was observed only at low levels of surimi added.

Increasing the protein concentration it is possible to increase the opportunity of protein-lipid interactions, forming more stable emulsions and decreasing the importance of the temperature for obtaining the emulsion. Blecker *et al.* (1997) reported that emulsifying capacity of whey protein concentrates increases with protein concentration until reach a maximal peak of emulsifying capacity.

Emulsions prepared using freeze-dried fat sleeper surimi showed better stability obtaining lower drainage ratios (Figure 2) than those prepared with tilapia. Addition of 0.5% of surimi powder (2c) produced emulsions with insignificant draining during the time of the test.

Difference on emulsion stability for each species could be attributed to myosin stability as subjected to freezing process, frozen storage or sublimation during freeze-drying. Stability of fish myosin during frozen is dependent on the fish species (Davis *et al.*, 1994) and the functional properties of the myosin such as emulsification capacity are dependent upon the degree of denaturalization of the protein Hsu, (1990). Denaturalization and/or aggregation of myofibrillar proteins proceed almost immediately after freezing are known to be associated with loss of solubility, as well as other functional properties in both frozen and freeze-dried surimi (Montejano *et al.*, 1984; Tejada, 1991).

Using both fish species, increased emulsification temperature provided more stability. The ability of a protein to diffuse at the interface increases when the viscosity of the solution decreases. Thus emulsion formation at elevated temperature will increase the opportunities for protein molecules to interact with lipids. In the other hand, the increase in emulsification temperature enhances the denaturalization process, exposing the hydrophobic groups of the protein that interact with the lipid phase.

However, meat batters emulsions are formed at temperature lower than 15 °C and then the batter stabilized by cooking at 60 °C. In the present work, temperatures were selected in the range of 15 to 35 ^{0}C, based on several studies reported on literature. Li-Chan *et al.*, (1984; 1985) determined that progressive heating of myosin protein concentrates induces gradual exposure of hydrophobic residues. Montejano (1984) and Chan *et al*. (1992) reported that fish myosin can have its hydrophobic residues exposed when denatured by mild heating (< 45 ^{0}C); after such temperature, gelation and protein aggregation take place. These phenomena occur by hydrophobic interactions and limit its functionality.

It was found that emulsion stability is increased when it is made with myosin heated in a temperature range close gelation. For surimi gelation temperature is near 40 ^{0}C (Wu *et al.*, 1985). The results obtained in this work shows that the better emulsification conditions can be obtained using freeze-dried surimi from fat sleeper at 0.5 % and an emulsification temperature of 15 ºC.

CONCLUSIONS

Results obtained in this work indicate that freeze-dried surimi can be used as emulsifier. This property is important in the re-structured and imitation meat products industry. Emulsion stability was affected for surimi level added and emulsification temperature. The fish specie used to produce the surimi had an important influence on the stability of the emulsion formed. Fat sleeper showed better emulsification properties than tilapia but both surimi products have potential as ingredient in meat emulsions.

Additional basic research is needed to characterize the surface-hydrophobicity of surimi proteins and its relationship with their oil and water-holding capacity.

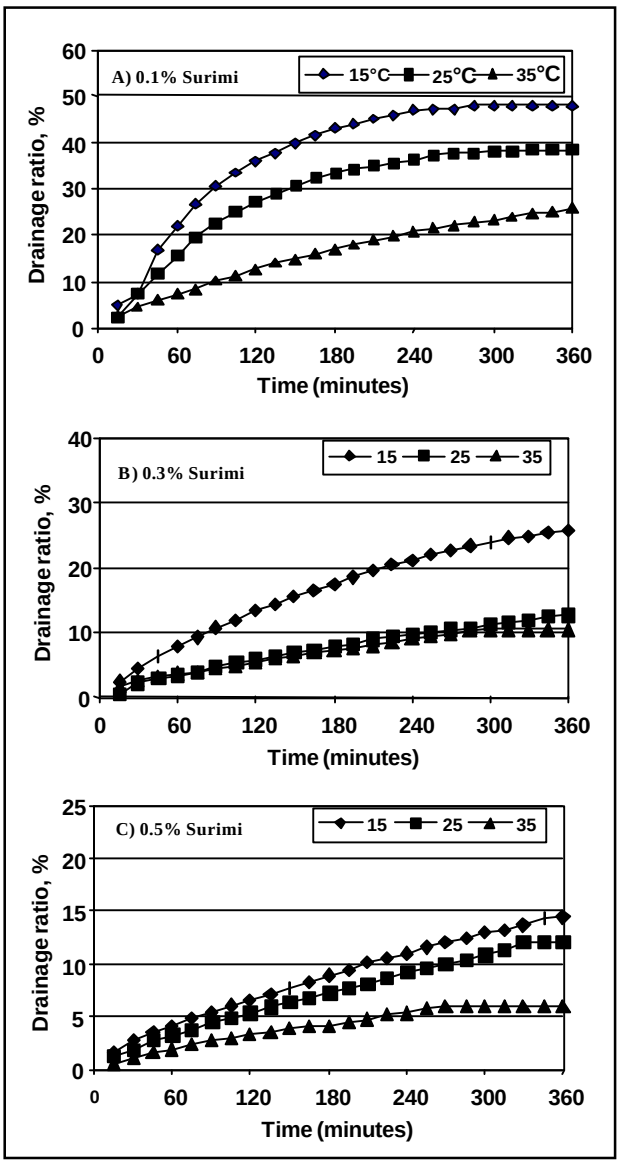


Figure 1. Drainage ratio of emulsions obtained with different levels of freeze-dried tilapia surimi under different temperatures.

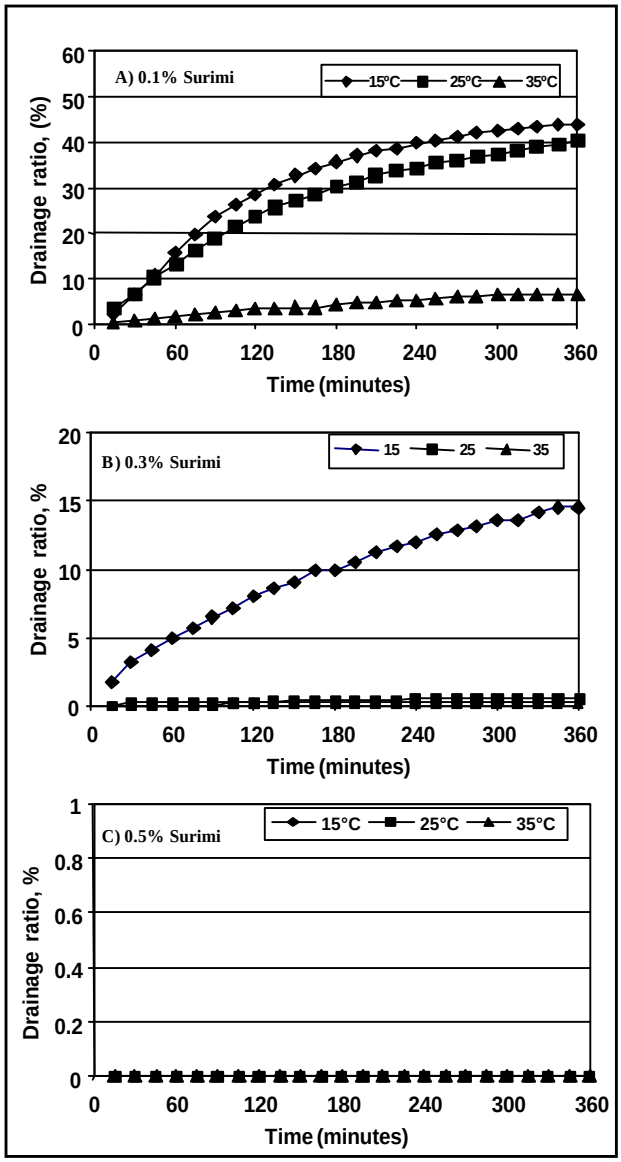


Figure 2. Drainage ratio of emulsions obtained with different levels of freeze-dried fat sleeper surimi under different temperatures.

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