

MODEL SYSTEM EVALUATIONS OF MEAT EMULSIONS PREPARED WITH DIFFERENT EDIBLE BEEF BY PRODUCTS AND FATS AND OIL

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ABSTRACT

Emulsion parameters of different meat by-products (beef head-meat, beef heart and liver) and animal fats and oil (beef fat, mutton fat, sheep tail-fat and corn oil) were studied in a model system. The results of the study showed that the highest emulsion capacity (EC) was with the heart meat and beef fat emulsion while the lowest EC was measured in the beef head-meat and sheep tail-fat combination. Corn oil gave the best emulsification with beef head-meat and liver, and beef fat resulted the second best results. Beef head-meat gave the most stable emulsion with all fats, but the emulsions prepared with heart and liver were generally unstable.

Key Words: Beef by- products, Meat emulsion, Emulsion characteristics, Model-emulsion

BİR KISIM KESİMHANE YAN ÜRÜNLERİNİN KATI VE SIVI YAĞLARLA OLAN EMÜLSİYON ÖZELLİKLERİNİN MODEL SİSTEMDE DEĞERLENDİRİLMESİ

ÖZET

Model sistemde, farklı et yan ürünlerinin (sığır baş eti, sığır kalbi ve karaciğeri) ve hayvansal katı yağ ve sıvı yağların (sığır et yağı, koyun et yağı, koyun kuyruk yağı ve mısırözü yağı) emülsiyon parametreleri çalışılmıştır. Sonuç olarak; sığır baş eti ve koyun kuyruk yağı kombinasyonu en düşük emülsiyon kapasitesini verirken, kalp eti ve sığır yağı emülsiyonu en yüksek emülsiyon kapasitesini vermiştir. Sığır baş eti ve karaciğeriyle en iyi emülsifikasyonu mısırözü yağı yaparken, sığır katı yağı da ikinci olumlu sonucu vermiştir. Sığır baş eti, bütün yağlarla da en stabil emülsiyonu oluştururken, kalp ve karaciğerden hazırlanan emülsiyonlar, genelde stabil olmayan emülsiyonlar vermiştir.

Anahtar Kelimeler: Et yan ürünü, Et emülsiyonu, Emülsiyon özellikleri, Model-emülsiyon

1. INTRODUCTION

There are several functional quality parameters, developed for the evaluation of meat emulsions, such as emulsion capacity (EC), emulsion stability (ES), emulsion viscosity (EV), gel strength (GS) and water and fat binding capacity. In general, these functional quality criteria in meat emulsions are influenced by the content of the meat proteins,

proportion of stroma proteins, conformational status of the proteins and emulsion preparation technique or conditions (Haq et al., 1973; Mittal and Osborne, 1985; Haque and Kinsella, 1989).

Meat emulsion systems have been studied by several researchers to test physical, chemical and technological properties of the meat proteins, but they have often reached different conclusions and

proposed alternative evaluation procedures (Smith et al., 1973; Lauck, 1975; Sofos et al., 1977; Ensor et al., 1987). However, the model system studies have often been preferred since they are convenient, economical, reproducible and require short time (Huang and Kinsella, 1987; Allan and Marvin, 1988; Zorba et al., 1993a; b).

There have also been various researches completed on the physico-chemical properties of the model system emulsions prepared with different meat and meat by-products. For example, poultry meats and edible meat by-products such as head-meat, heart tissue, liver and kidneys were among the meat related materials studied (Awad and Banu, 1977; Kissinger and Brauer, 1979; Gaska and Regenstein, 1981; Fischer, 1982; Lyon and Thompson, 1982; Perchonok and Regenstein, 1985; Gerigk et al., 1986). However, information on the meat related emulsion products particularly with different animal fats has not been widely available, and there is very limited information concerning the emulsion characteristics of meat and/ or by-products with sheep tail-fat which has very unique features compared to other animal fats (Zorba et al., 1993a, b; Unsal et al., 1995). Also, there have been many commercial problems encountered in emulsion stability during the processing of emulsion type meat products, probably due to the high level usage of this unique animal fats. Hence, it is important to obtain reliable, practical, technical and scientific information concerning edible meat by-products and various animal fats utilized to produce meat emulsions.

The objective of this experiment was to investigate the emulsion quality criteria and the emulsification properties of some edible meat by-products, with different animal fats, generally used in wiener type meat products by using a model emulsion system.

2. MATERIALS AND METHODS

The beef by-products and animal fats were purchased from a meat packer in Erzurum, Turkey. The beef head-meat (represents whole deboned head), heart and liver was from approximately 3 years old cattle, and was ground with a 3 mm diameter hole plate grinder. After wrapping with a medium density polyethylene film, the ground by-products were kept in a lab refrigerator (4 °C) during the study. Beef and mutton fat was precisely trimmed from different region of different carcasses such as surface and/ or between the muscles. The meat fats and sheep tail-fat were cooled to 4 °C and ground separately, then melted, filtered and stored in

glass containers at ambient temperature during the study. The corn oil was in commercial quality, while K_2HPO_4 and NaCl used were in analytical grade.

2. 1. Emulsion Capacity (EC)

EC was determined by using a model system with electrical end point determination as employed by Zorba et al. (1993a). Twenty five grams of ground by-product was comminuted using a Waring Blender (Model 34B199, Norwalk, CT) for 3 min at 13,000 rpm with a 100 ml of cold (4 °C) salt-phosphate (SP) solution (0.5 % K_2HPO_4 in 1 M NaCl). The slurry (12.5 g) and 37.5 ml of additional SP solution were transferred into another blender jar and homogenized 10 s at low speed (\approx 5,000 rpm). Then, 50 ml of the treatment fat or oil was added. The melted animal fats or corn oil which was maintained at 50 °C in a specially constructed water jacketed buret and was added at the rate of \approx 0.7 ml/s using a blender speed of 13,000 rpm. At the breaking point, determined by a sudden increase in electrical resistance, the fat or oil addition was ceased and the total amount of dispensed fats or oil was recorded. Then, the EC was calculated as ml fat or oil/ g protein on the base of Kjeldahl protein content of the by-products (Ockerman, 1976).

2. 2. Emulsion Viscosity

With the same system, a newly formed 25 g of the emulsion was transferred into a cellulose nitrate test tube and the viscosity value was determined with Pleuger Viscosimeter (Pleuger NDJ-1, Belgium) as described by Zorba et al. (1993b). The evaluation was conducted at 18- 20 °C using a No 4 spindle device at 30 rpm rotation speed, and the results were reported as centipoise units.

2. 3. Emulsion Stability (ES)

ES of the meat by-products in an emulsion system was determined using the same system as described in EC test. In the ES determination, however, the emulsion forming process was ceased when the total amount of fats or oil reached 100 ml, and this was mixed 10 additional seconds. Then 20 g of the formed emulsion was immediately weighed into a cellulose nitrate test tube and capped. The tube was then transferred to a 80 °C water bath and held until the internal temperature of the emulsion reached 72 °C. The tubes were then centrifuged for 15 min at 1200 rpm (400 G) and were drained into a volumetric cylinder for 12h to determine the unbound fat or oil and water. ES was calculated as a percentage (%) from the amount of fats or oil plus water released by the emulsion (Ockerman, 1985).

2. 4. Proximate Composition and pH Analysis

The moisture content using the standard dry oven method (100 °C for 18h), fat content with the modified babcock and total protein content by the Kjeldahl method were determined as described in the standard procedures for muscle tissue (Ockerman, 1985). The pH value of the by-products was measured by using a pH meter (PYE UNICAM Model 290 Mk-2, Cambridge, UK) as outlined by Ockerman (1985).

2. 5. Statistical Analysis

The data obtained in this study was subjected to ANOVA, using a factorial design. Basic statistics and analysis of variance were performed to test significance within replications and between the treatments, and the significant means were subjected to Duncan Tests (SAS, 1985). The experimental design was a 3x4x3 factorial design (3 different beef by-products), and 4 different fats and oil, with 3 replications.

3. RESULT AND DISCUSSION

3. 1. Proximate Composition and pH Values

The beef head-meat had the highest fat but the lowest protein content among the by-products, with second highest pH value among the tissues (Table 1). However, liver had the lowest fat content but had the highest protein content and pH probably because high protein content and pH value of meat or by-products (Ockerman, 1983; Ockerman and Hansen, 1988) of different chemical and physical structure when compared to heart and head-meat. In general, a better emulsion parameters is anticipated from the high protein content and pH value of meat or by-products (Ockerman, 1983; Ockerman and Hansen, 1988).

Table 1. Proximate Composition and pH of the different by-products

Tissues	Moisture %	Fat %	Protein %	Tissue pH
Head-Meat	67.23	13.90	14.79	5.97
Heart	75.70	6.00	16.71	5.49
Liver	70.02	1.25	20.76	6.01

3. 2. Emulsion Capacity (EC)

There were significant differences ($P < 0.05$) between the tissues, and the fats or oil and also the

fat or oil within each tissue or the tissue within each fats or oil for EC (Figure 1). It is apparent that heart meat had a higher EC than the that of liver and head-meat, with all fats and oil studied in this experiment. Also heart meat had always higher EC with all of the animal fats when compared to the other by-products (Figure 1). These results might be related to the structure of heart proteins, that are myofibrillar proteins which are important for an acceptable emulsification (Gaska and Regenstein, 1981; Haque and Kinsella, 1989). It is well known that myofibrillar proteins have a long thread like structure which contributes to the emulsification process by encircling more fat molecules (Mangino, 1991). Additionally, liver and head-meat gave the highest EC with corn oil while heart had the highest EC with beef fat in the materials used. A lower EC results with head-meat would be expected due to its collagen content, that is, generally stroma proteins has low EC in meat emulsions (Ockerman and Hansen, 1988; Gökalp et al., 1990). Mutton fat had the lowest EC with liver while sheep tail-fat having the same result with hear-meat, but it gave satisfactory EC with heart-meat. A good emulsification with sheep tail-fat and red meat could be extrapolated from the above observations.

3. 3. Emulsion Viscosity (EV)

The EV results of the by-products (Figure 2) are significantly ($P < 0.05$) different with various fats or oil as well as tissue and the tissue within each fat or oil, or fat or oil within each tissue. For instance, liver had significantly lower EV with all fats and oil when compared to the other by-products; however, a significantly higher EV was observed with corn oil for all by-products. Also, head-meat showed unexpectedly high EV with all fats and oil combinations, it had the highest EV with corn oil. The reason for this result, might be due in large part to the relatively high pH and the higher solubility of the proteins with the SP solution. Similar results were reported by Turgut et al. (1981) and Zorba et al. (1993b) with the parallel explanations. Also, head-meat had lower moisture and higher fat content when compared to the other by-products (Table 1). Therefore, the difference in composition might have influenced the viscosity. There were no significant differences among the animal fats and oil for EV with all of the by-products emulsions (Figure 2). Also, non-significant differences were obtained between heart and head-meat for EV in the presence of sheep tail-fat. This fat also gave the lowest EV with liver among the other fats and oil. No explanation could be stated for this result at this moment. The alteration of the EV was usually inconsistent with the by-products and the animal

fats, however, utilization of the vegetable oil, in general, increased the EV with all by-products studied in this research (Figure 2).

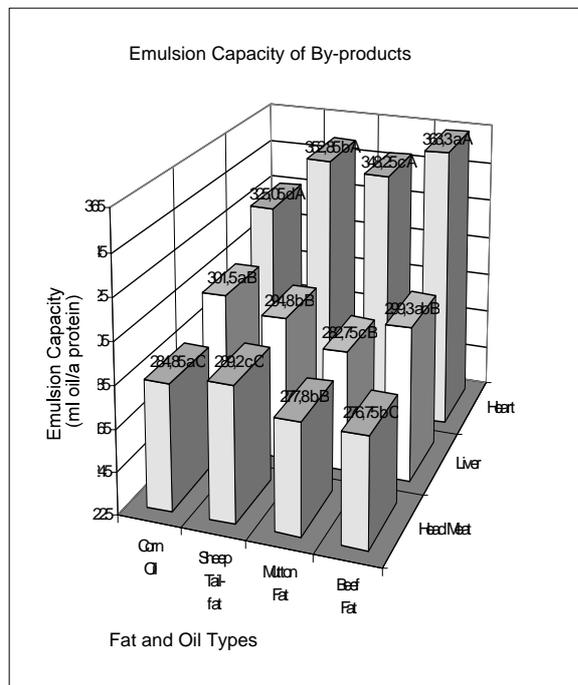


Figure 1. The emulsion capacity of different meat by-products in presence of different animal fats and oil.

A, B, C: Means with the same uppercase letters on a bar column are not significantly different ($P > 0.05$).
a, b, c, d: Means with the same lowercase letters on a bar row are not significantly different ($P > 0.05$).

3. 4. Emulsion Stability (ES)

In general, animal fats seemed to have poor emulsion stability with the by-products studied in this research. For example, head-meat showed a partial stability with all fats, except mutton fat, while heart had a measurable stability only with the vegetable oil. However, liver had no stability in any of the fats or oil used in the ES observations. The reason might be due to the physico-chemical structure of the by-product and/ or its proteins in which the water and oil may have been more readily released. In general, an emulsion with thicker consistency (higher viscosity) may not be easily broken, and these emulsions could indicate more consistent, stable and visco-elastic meat products (Zorba et al., 1993b). Liver had the lowest viscosity (Figure 2), namely thinner consistency and resulted in unstable emulsions confirming the previous statement.

The results of this study showed that the emulsions having low EV had almost no measurable stability.

Escher et al. (1983) suggested that in determination of the rheological quality of an emulsion, analysis of the viscosity would be a better predictor than chemical tests to ascertain the textural quality of the final product. This is in agreement with the concept stated by some researchers (Szczesniak, 1963; Rao

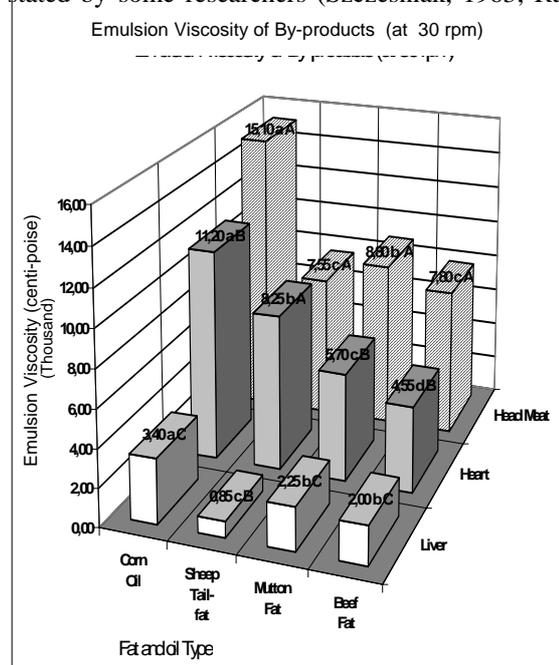


Figure 2. The emulsion viscosity of different meat by-products in presence of different animal fats and oil.

A, B, C: Means with the same uppercase letters on a bar column are not significantly different ($P > 0.05$).
a, b, c, d: Means with the same lowercase letters on a bar row are not significantly different ($P > 0.05$).

et al., 1975; Man et al., 1976) that the textural quality attributes of food products are usually correlated with their rheological characteristics. Hence, most of the emulsion quality parameters could be evaluated or predicted with EV alone.

4. CONCLUSIONS

In general, the emulsion capacity and viscosity of heart meat were higher than that of the other by-products. That might be as a result of the physico-chemical attributes of the heart proteins that are myofibrillar protein. EC of head-meat and EV of liver were not significantly altered with the type of fat, while the heart tissue showed reversed consequences. Also, the meat by-products with low viscosity (thin consistency) had generally unstable emulsions in the model systems indicating a good relationship between EV and ES that would be a valuable quality criteria in meat industry.

In this study, the emulsion parameters showed different behaviors due probably to different tissue structures and differences in chemistry of the fats. For example, animal fats used in this study were unrefined while the vegetable oil was refined. In general, sheep tail fat seemed to give satisfactory results for measured emulsion characteristics when compared to other animal fats. Also, the vegetable oil presented more stable and viscous (thicker) emulsions when compared to the animal fats. This shows that physical structure of the oil seems to be more suitable for optimum emulsification and stability in model emulsion systems. In conclusion, however, it may be stated that further studies are needed to assess the real status of these fats and by-products in actual and/ or model meat emulsions.

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