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Research Article

Emulsion Properties of Quince Waste

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Abstract

Nowadays many studies have focused on food waste. With an expanding population and a wide variety of foods, the food sector is always expanding. In addition to production, there is also an increase in the development of food waste. These wastes result in economic difficulties, environmental damage, and the loss of priceless chemical components. The processing of fruits and vegetables generates the most waste. Quince is a fruit that is difficult to consume directly and is usually processed into jam or fruit juice. In this study, some emulsion properties of quince waste were investigated. Oil in water (O/W) emulsions formed with four different concentration (0.5%, %1, %2 and %3) of quince waste and no quince waste for the control grup. The emulsions' major constituents were chicken breast and corn oil. Quince waste decreased emulsion' pH from 5.96 to 5.53. Emulsions manufactured with quince waste has the higher emulsion stability for all used concentrations (between 83.2 to 85.6) with respect to the control (80.6). Quince waste emulsions were found to have pseudoplastic character and exhibit shear thinning behavior. Quince waste samples used in study contribute the chicken type O/W emulsion in terms of emulsion stability and rheological properties.

Keywords: Food waste, Quince waste, Emulsion capacity, Emulsion stability, Emulsion rheology.

Ayva Atığının Emülsiyon Özellikleri

Öz

Günümüzde birçok çalışma gıda israfına odaklanmıştır. Nüfusun ve gıda çeşitliliğinin artması ile gıda sektörü sürekli genişlemektedir. Artan gıda üretimiyle beraber açığa çıkan gıda atığı miktarı da artmaktadır. Bu atıklar ekonomik kayıplara, çevresel hasara ve değerli kimyasal bileşenlerin kaybına neden olmaktadır. Gıda atıklarının önemli bir kısmını meyve-sebze atıkları oluşturmaktadır. Ayva, doğrudan tüketilmesi zor olan ve genellikle reçel veya meyve suyuna işlenen bir meyvedir. Bu çalışmada ayva atığının bazı emülsiyon özellikleri araştırılmıştır. Ayva atığı içermeyen kontrol grubu ve ayva atığının dört farklı konsantrasyonu (%0.5, %1, %2 ve %3) kullanılarak su içinde yağ (O/W) emülsiyonları oluşturulmuştur. Emülsiyonların ana bileşenleri tavuk göğsü ve mısır yağıdır. Ayva atığı, emülsiyonun pH'ını 5,96'dan 5,53'e düşürmüştür. Ayva atığı ile üretilen emülsiyonların stabilitelerinin (83.2 - 85,6) kontrole (80.6) göre daha yüksek olduğu belirlenmiştir. Ayva atık emülsiyonlarının psödoplastik karaktere sahip olduğu ve kayma incelmesi davranışı sergilediği tespit edilmiştir. Çalışmada kullanılan ayva atığı örnekleri, emülsiyon stabilitesi ve reolojik özellikler açısından tavuk tipi O/W emülsiyonuna katkı sağlamıştır.

Anahtar Kelimeler: Gıda Atığı, Ayva Atığı, Emülsiyon Kapasitesi, Emülsiyon Stabilitesi, Emülsiyon Reolojisi.

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1. Introduction

The food sector has put more of an emphasis on waste product evaluation recently, both to prevent the loss of these essential ingredients and to reduce environmental issues brought on by these wastes [1]. The processing of food results in significant amounts of food waste. Following the production of fruits and vegetables, wastes contain the highest amount of food [2]. Lignocellulose, protein, fat, sugar, phytochemicals, and other useful components are typically abundant in plant-derived wastes [3] and they might be returned as worthwhile goods that benefit the food, cosmetics, and pharmaceutical businesses financially [4]. The analysis of these substances from food waste not only lessens environmental concerns but also improves the economic competitiveness and sustainability of the agri-food sectors; because consumers prefer natural supplements, by-products of the food sector that are high in dietary fiber and bioactive chemicals are particularly useful [3, 4]

The quins fruits' usage in the food business is constrained by their high lignin content. A barrier to the long-term storage of this fruit is its propensity to decay and turn brown [5]. Due to its low moisture level, high acidity, woody flesh, significant amount of stone cells, and astringent flavor from lignum growth, quince fruit is challenging to digest. Numerous studies have demonstrated the value of quince jam and other by-products as a good and affordable source of flavonoids, phenolic acids, and antioxidants [1, 6, 7].

In this study, quince waste (QW) was investigated for some emulsion properties. The effect of QW on emulsion formation and their potential for chicken meat emulsion were investigated.

2. Material and Method

2.1 Materials

Quince waste (QW) is obtained in food research laboratory in a similar way with fruit juice production. Quince waste was dried, grinded and screened from 750µ sieve kept at 4°C in a dark bottle. Chicken breast and corn oil were purchased in a local market in Samsun, Turkey.

2.2 Methods

2.2.1. pH analysis

A pH meter (Hanna Instruments HI2211) probe was inserted into the emulsions to determine their pH [8].

2.2.2. Emulsion Capacity of the samples (EC)

The suspension and oil mixture was added to the emulsion system and homogenized constantly as the burette slowly added 0.9–1.0 mL of maize oil at a time. Through the use of copper conductor bars installed in the system, the instantaneous change in the ammeter was used to gauge the emulsion's completion. Electrical conductivity was observed, and the system was shut off when a sharp decline in conductivity was noticed. The total amount of oil in the emulsion was used to calculate the emulsion capacity [9].

2.2.3. Emulsion Stability of the samples (ES)

The 10±0.9 g of prepared emulsions were weighed in a test tube and heated in a water bath at 80±2°C for 30 minutes. The samples were centrifuged at 2000 g for 10 mins after they had cooled to room temperature. The liquid phase was separated following centrifugation and quantified in millilitres (mL); the emulsion stability was determined with the following formula; [9]

ES(%)=100-(Volume of liquid separated from emulsion (mL))*10

2.2.4. Rheology of the emulsions

The emulsion samples were subjected to rheological investigation in a HAAKE Mars III Rheometer (HAAKE Co., Germany) with cone and plate geometry (diameter: 35 mm, gap interval: 0.052 mm). For flow curve (steady-state) analysis, samples were subjected to shear rates ranging from 0-100 s-1 for three minutes while measurements were made at 25°C.

3. Results and Discussions

3.1. pH Analysis of the Emulsions

The pH value is one of the most important factor effect many parameters of the emulsions. The pH values of the emulsions were given in Table 1. The pH values of the emulsions were determined to be between 5.53 to 5.96. According to the Duncan multiple comparison test results, the addition of 0.5% and 1% quince waste did not cause any change on the pH value of the emulsions compared to the control group. The addition of 2% and 3% quince waste caused a decrease in the emulsion pH, and statistically these two ratios caused in the same decrease in pH.

3.2. Emulsion Capacity (EC)

The highest amount of mL fat that 1 g of protein can emulsify is known as emulsion capacity (EC) [8]. The EC of quince waste emulsions were given in Table 1. The EC values of the emulsions were determined to be between 147.37-188.75 mL fat/g protein. The addition of QW to the emulsion caused a decrease in the emulsion capacity. While the EC of the control sample was 184.71 mL fat/g protein, the emulsion capacity decreased as the added quince waste concentration increased. When the pH values of the emulsions are examined, it is seen that the pH value of the control group is 5.96 and pH values of the emulsions reduced by the addition of QW. The isoelectric point and the solubility of proteins is greatly impacted by the pH, a crucial environmental component [10], so the EC value of the emulsions decreased depending on pH. According to Duncan's multiple comparison test results, the highest EC was determined in the sample 0.5% quince waste added (168.96), and the lowest EC in the sample 3% quince waste added (152.91).

Table 1. pH, EC and ES values of QW emulsions

	%0 (C)	%0.5	%1	%2	%3
pH	5.96±0.0^{A}	5.93±0.1^{A}	5.83±0.1^{A}	5.53±0.1^{B}	5.57±0.1^{B}
EC	184.7±5.9^{A}	168.9±1.7^{AB}	167.6±3.1^{BC}	160.2±1.3^{C}	152.7±1.4^{D}
ES	80.6±2.1^{B}	83.2±0.6^{AB}	85.6±2.4^{A}	84.8±1.13^{AB}	83.6±2.1^{AB}

*Mean ± standard deviation. A-D: There is a statistically significant difference in the same line ($p < 0.05$)

3.3. Emulsion Stability (ES)

The capacity of an emulsion's qualities to withstand changes over time is referred to as "emulsion stability." The rate of change of an emulsion's characteristics increases with its stability. Numerous physical and chemical mechanisms can cause emulsions to become unstable [11]. The ES values of the quince waste emulsions are between 85.60-83.20% and the ES values of all concentrations are higher than the ES value of the control sample. According to Duncan multiple comparison test, the highest ES value was determined in the emulsion with 1% quince waste. The ES values of 0.5%, 2% and 3% waste-added emulsions were not statistically different from each other. Specific amino acids provide proteins their hydrophobic and hydrophilic characteristics, which allow them to interact with both water and oil molecules and function as emulsifiers. Protein contents of both chicken meat and quince waste contributed the stability of emulsions.

3.4. Emulsion Rheology

The emulsions obtained with different concentrations of quince waste and the control emulsion were subjected to rheological analysis without any heat treatment. The ratio of the shear stress to the shear rate is what is known as viscosity (resistance to flow). Viscosity curves of emulsions prepared with quince pulp at different concentrations are given in Figure 1.

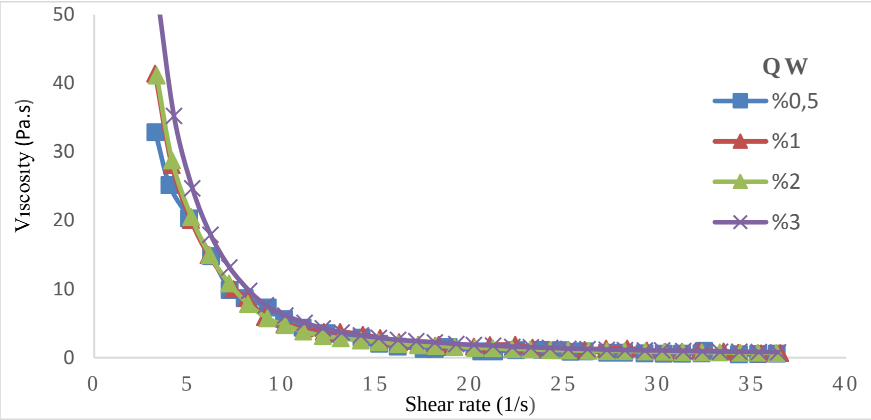

Figure 1. Viscosity curves of QW emulsions

Viscosity curves depict that viscosity decreased with increasing shear rate, that is, emulsion samples were featured shear thinning behavior. The highest viscosity was seen in 3% QW emulsion, the higher quince waste concentration has higher viscosity. At the 10 s^{-1} shear rate, the viscosity of almost all QE emulsions approximately reached to 5 Pa.s. Figure 1 depicted Non-Newtonian behavior, which shows the viscosity decreasing as shear rate increases. During dispensing, the shear force reorganizes the random polymer chains into an aligned conformation that reduces viscosity during the process. Most polysaccharide solutions show non-Newtonian flow, and an increase in shear rate affects viscosity [12].

Comparison between viscosities were done using the apparent viscosity (η_{50}) reference values at a shear rate of 50 s^{-1}, reported to be an effective shear rate [13]. Flow behavior graph for quince waste emulsions were shown in Figure 2. The apparent viscosity of QE samples were increased greatly when the quince waste concentration was increased from 0.5% to 1%. The viscosities of emulsions using 1%, 2% and 3% quince waste were similar.

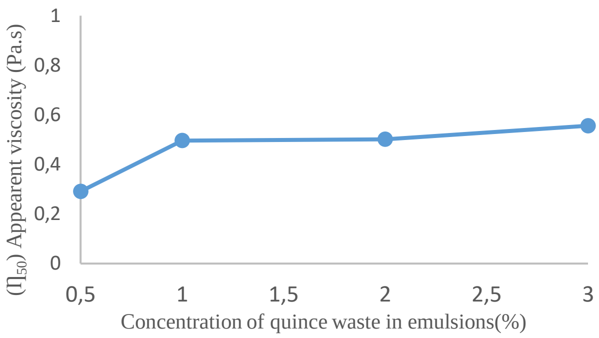

Figure 2. Flow behavior of QE samples

Figure 3 depicts the flow graph shear rate (γ) versus shear stress (τ) of QE emulsions. The most concentrated sample (3% QE) at the same shear rate resulted in higher shear stress. In increasing concentrations, the polysaccharide aggregation probably forms a three-dimensional network structure, so it requires more energy to break the network structure [14].

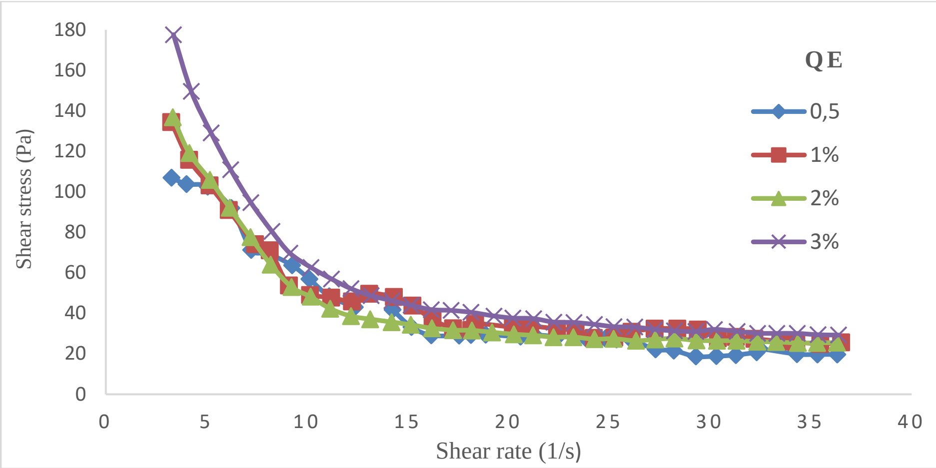

Figure 3. Flow behavior curves of QE samples

This behaviour is expected as an increasing shear-rate disrupts the native structure of emulsion and aggregates, leading to a decrease in overall resistance to flow. Hence, shearing action during measurement of rheological properties affects the weak forces, such as hydrogen bonding and van der Waals force [15].

An appropriate rheological equation could be used to fit the shear-rate/shear-stress data. Ostwald de Waele model was successfully applied to all of the emulsions formed with QW and the results are given in Table 2. K; is the consistency index and is related to the increase in viscosity of solutions, n; It is the flow behavior index, a parameter that determines the shear thinning quality of the solutions [15] [14] [16].

Table 2. Rheological analysis of QW emulsions

Quince waste concentration	Ostwald de Waele Model Parameters			Appeerent viscosity (Pa.s)
	K (pa.s^n)	n	r	η_{50}
%0.5	225.2	0.5833	0.9935	0.291
%1	321.4	0.7287	0.9988	0.496
%2	382.8	0.7790	0.9984	0.501
%3	504.5	0.8523	0.9982	0.556

The degree of pseudoplastic behavior can be measured by the flow behavior index (n). The n values of the quince emulsions increased with increasing concentration and ranged from 0.5833 to 0.8523. Similarly, the K values increased in direct proportion to the concentration and ranged from 225.2 to 504.5.

4. Conclusions and Recommendations

One of the important problems that the food industry needs to solve is food waste. Fruits and vegetables wastes constitute the majority of these wastes. Quince waste was investigated in order to evaluate its emulsion properties. Quince waste pH directly affected emulsion pH. Although the addition of quince waste decreased the EC value of emulsions, it increased the stability of the emulsions for all concentrations used. In general, the addition of waste improved the textural properties of the emulsions. According to the results of rheological analysis; Pseodoplastic character and shear thinning behavior, which is usually seen in polysaccharide solutions, were determined. To develop more efficient emulsion treatments, it is essential to have a better understanding of the factors that affect emulsion formation and stability.

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Nomenclature

EC : Emulsion capacity
ES : Emulsion stability
QW : Quince waste
QE : Quince waste emulsion

Declaration

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