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Feasibility study of a natural vinaigrette from olive (*Olea europaea*) oil and lemon (*Citrus limonium*) juice-based lemon albedo extract

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ABSTRACT

The present paper reports on the feasibility study of a natural vinaigrette from olive (*Olea europaea*) oil and lemon (*Citrus limonium*) juice-based lemon albedo extract. The albedo extract was prepared at different albedo to lemon juice ratios. The physical stability of different vinaigrette samples, in terms of creaming behaviour, was adopted as quality criterion. The most stable sample was then analysed for its rheological behaviour. According to preliminary results, the most physically stable vinaigrette could be obtained at albedo: lemon juice ratio of 1:15.1 (w/w). The corresponding dressing showed a stability of six days and a shear-thinning type rheological behaviour. So, the formulation of natural vinaigrette from olive oil, lemon juice and lemon albedo is feasible but such formulation is of short-term physical stability, which is a general well-known characteristic of natural and minimally processed food products. In our opinion, this study merits further research, in order to: i) better optimize the vinaigrette formulation, and ii) characterize the functional properties of the final product.

Introduction

In recent years, nutrition has been considered as a determining factor in sustaining and restoring health. Various processed food products have been incriminated in the appearance of severe diseases such as cancer, hypertension, diabetes, etc. (Medeiros et al., 2012). In particular, Ngo et al. (2011) brought up the undesirable effects of synthetic ingredients on human health.

Emulsifiers represent a group of essential ingredients used to stabilize heterogeneous liquid systems. In the case of olive-in-water emulsions, emulsifiers are usually added to the aqueous phase to improve their stability against creaming.

Polysaccharides are known to be among the most employed emulsifiers in food industry. Pectins, sub-group molecules belonging to polysaccharides, are widespread in citrus peels. They have many functional properties such as the stabilizing power of food emulsions. These molecules are obtained in purified form via numerous technological operations implicating various chemical extraction agents (Seixas et al., 2014). On the other hand, there is an emphasis on investigating natural emulsifiers that can be efficiently incorporated into various food emulsions (Yang & McClements, 2013). As pointed out by Rezzadori et al. (2012) about pectin extraction, the idea is to apply an alternative process that does not generate toxic waste. In this context, Fidalgo et al. (2016) have studied the simultaneous extraction of pectin and essential oils from orange and lemon peels, using only water as dispersing medium. Banerjee et al. (2016) have evaluated the effect of lemon juice on pectin extraction from mango peels.

While the instantly prepared lemon olive oil vinaigrette is now very popular, particularly in the Mediterranean countries, there is, to our knowledge, no work about the stabilisation of such products with only natural raw ingredients, including emulsifiers. In this respect, the few studies devoted to this subject have used purified polysaccharides as

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stabilizers (Abedinzadeh et al., 2016; Silva et al., 2010; Paraskevopoulou et al., 2007; Paraskevopoulou et al., 2005).
The present paper reports on the feasibility study for natural vinaigrette from olive (*Olea europaea*) oil and lemon (*Citrus limonium*) juice-based lemon albedo extract (LAE), at olive oil:LAE ratio of 1:1.2 (v/v). Such natural formulations, despite their short shelflife, refer currently to a major trend at global level (Silveira et al., 2013).

Materials and methods

Materials

The virgin olive oil from *Chemlal* olive variety was collected in Bouira region (120 km south east of Algiers).
Lemon albedo was recovered by peeling local lemon fruits. The albedo was separated from coloured peel (flavedo), cut in small size pieces (~ 2mm) and then dried at 50 °C until a constant weight.
The lemon juice was freshly extracted using a home lemon-press and then centrifuged.

Vinaigrette Preparation

In total, 10 vinaigrette samples were prepared, according to diagram in Figure 1, proposed here for the first time to our knowledge.
The LAE was prepared by mixing 145 mL hot lemon juice with lemon albedo small pieces at the following mixing ratios (w/v): 1:24.2, 1:20.7, 1:18.1, 1:16.1, 1:15.6, 1:15.1, 1:14.6, 1:14.1, 1:13.7 and 1:13. The homogenization was performed using an Ultra-Turrax T25 homogenizer (IKA Instrument, Germany) equipped with a dispersing tool (S25-N). Shortly after, each vinaigrette sample was divided equally into six 15 mL- polypropylene tubes with a conical bottom which were then stored at room temperature to monitor the physical stability.

Physical Stability Analysis

As underlined by Sosa et al. (2014), the stability of food emulsions is a key factor in the development of such products. The physical stability in particular indicates the ability of emulsion to resist changes in spatial distribution of ingredients over time (McClements, n.d), thus mainly determining the shelf life of the product (Junqueira et al., 2018).
The stability was estimated by monitoring over time of the creaming behaviour (demixing kinetics). For this, the serum volume separated on the bottom of tubes was measured at different time intervals and the curve fitting was performed using Excel software. The lower the creaming rate, the more stable the vinaigrette.
The most stable vinaigrette was further analysed for its rheological behaviour. A constant rheological behaviour over time indicates a better physical stability.
The rheological analysis was performed using the VT550 viscotester (Thermo Haake). The flow curves of vinaigrette samples were obtained at 20 °C at various shear rates (0-400 s^{-1}) for five minutes.

Results and discussion

The creaming behaviour of obtained vinaigrette samples is illustrated in Figure 2a. As can be seen, straight lines are obtained for all samples, except for those with a lemon albedo:lemon juice ratio below 1:20.7 (w/v), indicating the influence of albedo proportion on the creaming kinetic. We think that the pectin could be the determining factor in the emulsifying ability of the lemon albedo. It is worthwhile to note that the citrus pectin, as a natural hydrocolloid (Korish, 2015) could be an interesting alternative emulsifier, stabilizer and gelling agent (Gull et al., 2018), considering its capacity, as hydrocolloid, to increase the viscosity of multiphase systems (Venir and Maltini, 2013, Prabhuswamy et al., 2019). Our findings are in concordance with those communicated by Santiago et al. (2002) regarding the effect of polysaccharide concentration on the creaming kinetics of oil-in-water emulsion.
The best stability that has been reached is about six days and corresponds to the creaming rate very close to zero. It was obtained with the albedo:lemon juice mixing ratio of 1:15.1 (w/v) that is 9.6 g lemon albedo for 145 mL boiled lemon juice. This stability is close to that (four days) communicated by Perrechil et al. (2014) about an emulsion stabilized by sodium caseinate- locust bean gum Maillard conjugates used as substitutes of synthetic emulsifiers. Despite the short shelf life of natural and minimally processed products, many researchers encourage their consumption regarding their positive effects on health (De Podesta et al., 2007).
It should be noted that in our case, the lemon albedo: lemon juice ratio in the LAE cannot be increased beyond 1:15.1 (w/v), otherwise the vinaigrette loses the fluidity characteristic of this type of product. At last, a full understanding of the emulsifying-stabilizing effect of the LAE is not so easy, knowing the structural complexity of the oil-in-water emulsions (Johnston et al., 2015).
The flow curves of the most stable vinaigrette, at different storage times, are presented in Figure 2b.

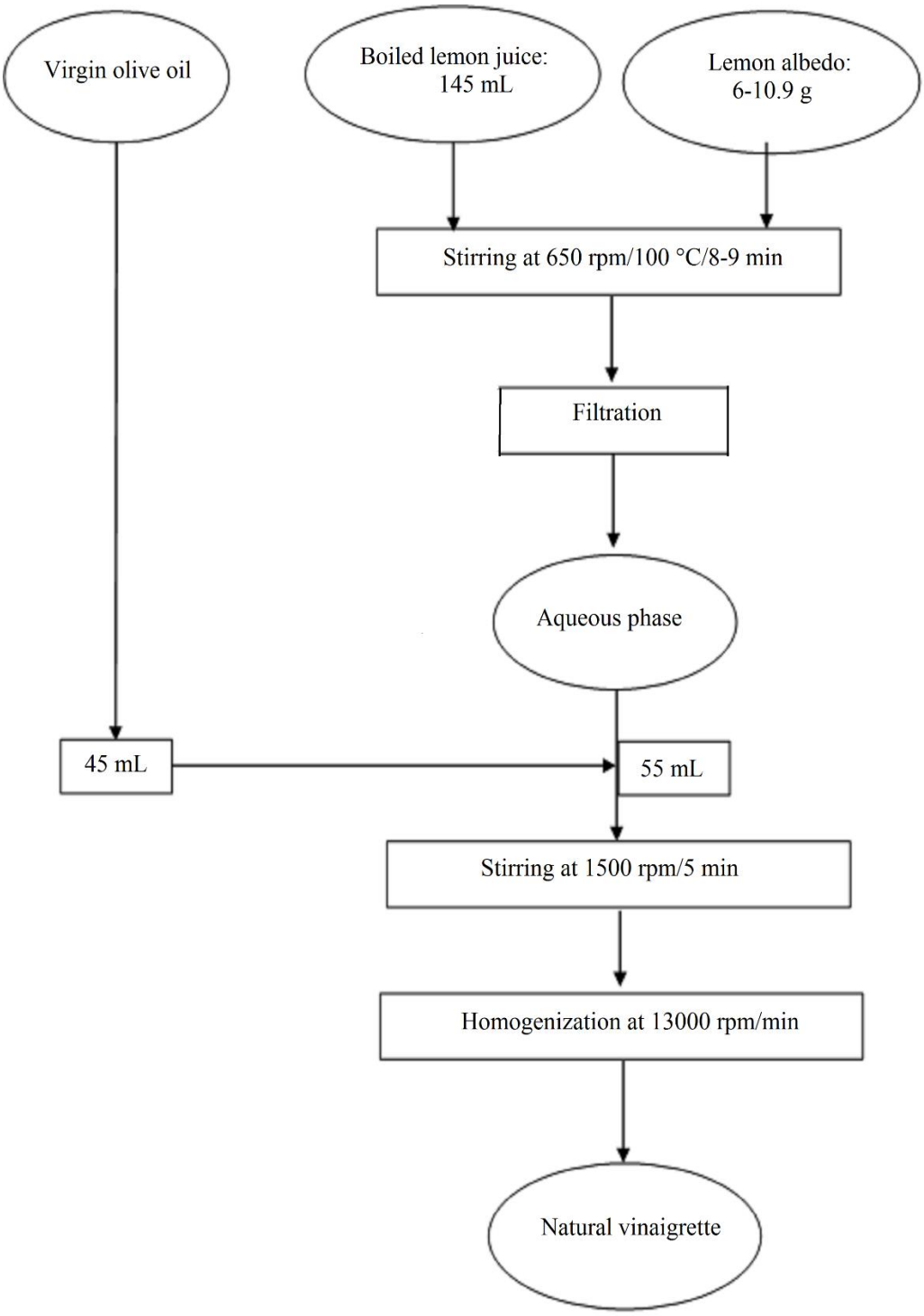

Figure 1. Diagram of preparation of natural vinaigrette samples

From Figure 1, the selected formula seems to safeguard its rheological stability at shear rates not exceeding 40 (1/s). At this shear rate, the overall shape of flow curves does not change during the storage period of six days. As highlighted by Bosco et al. (2019), regarding rheological parameters of shear-thickening fluids, this observation may be linked to the fact that low shear rates marginally impact the viscosity values and thus the microstructure of vinaigrette. The regression of ln(shear stress (τ)) versus ln(shear rate (γ)) (not presented here), allowed us to deduce the values (below 1) of behaviour index n, demonstrating a rheological behavior of shear-thinning type. These findings are consistent with those reported by Nikovska (2012) concerning olive oil-in-water emulsions with lower protein emulsifier concentration.

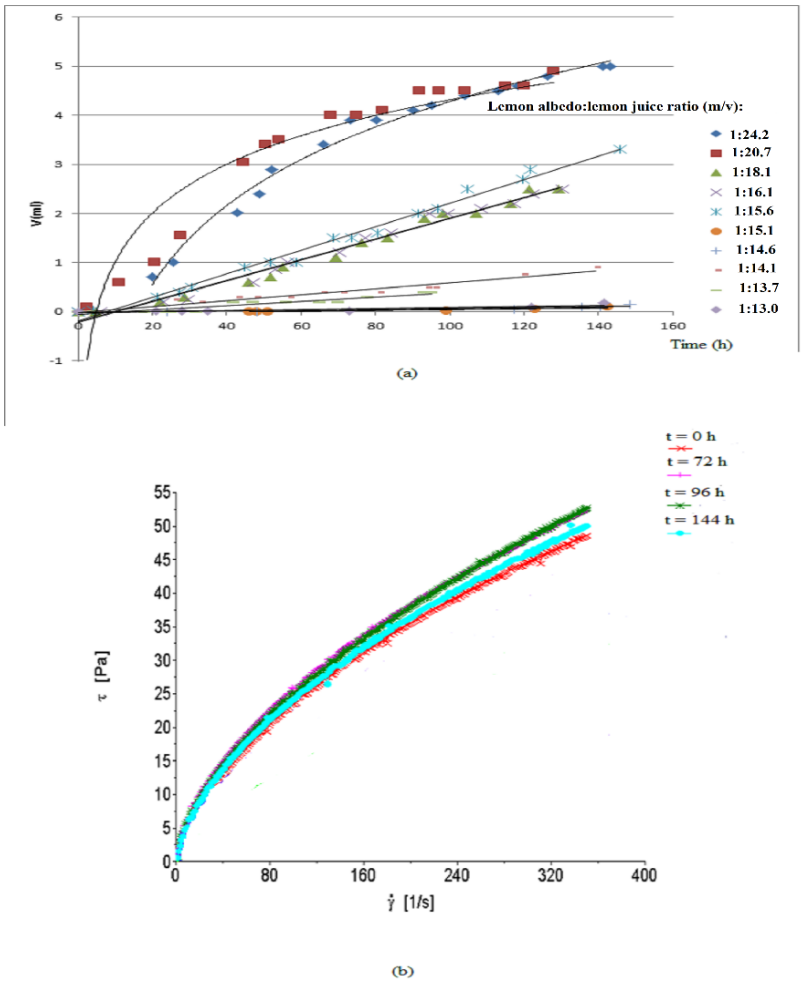

Figure 2. Serum Volume of separated serum versus storage time, for all tested vinaigrette samples (a), and flow curves at different storage times of the most stable vinaigrette sample (b).

Conclusions

Results show that the formulation of natural vinaigrette from olive oil, lemon juice and lemon juice-based lemon albedo extract is feasible, by choosing the appropriate proportions of components. The best physical stability reached is of six days, knowing that the short-term stability is a general characteristic of natural processed food products.
In our opinion, this study needs to be developed, in order to: i) better optimize the vinaigrette formulation, and ii) characterize the functional properties of the final product.

Author Contributions: Chekroune M. conceived, designed and performed the experiments. Benamara S. supervised the work and he rewrote the manuscript by updating the bibliographic research.
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