

P-089 Emulsifier properties of polar lipid fraction from oat (*Avena sativa*)

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INTRODUCTION AND OBJECTIVES

In this study a polar lipid fraction extracted from oat (*Avena sativa*) is used to produce oil-in-water (O/W) emulsions and its properties as an emulsifier are evaluated. The main objective is to find out if the polar lipid fraction from oat can be used as an effective emulsifier. Other objectives are to produce yellow O/W emulsions using oil containing lutein as an oil phase and to dry the emulsions with a spray-drier using maltodextrin as wall material.

MATERIALS AND METHODS

The polar lipid fraction was extracted from oat using a supercritical fluid process developed in an earlier project of University of Turku and MTT Agrifood Research Finland (Aro 2007). With this process polar lipids can be isolated in a pure, solvent-free form.

Commercial rapeseed oil was used as an oil phase for emulsions. For producing yellow emulsions, rapeseed oil containing approximately 200 ppm lutein extracted from marigold flowers (*Tagetes erecta*) was used as an oil phase. A dilute citrate-phosphate buffer was used as an aqueous phase for the emulsions. Based on preliminary studies the oat polar lipid fraction seemed to work better in a low pH, so we used a pH 2,6 buffer (0,1 M citric acid, 0,2 M disodium hydrogen phosphate and water in proportion 223 : 27 : 250, respectively).

For small scale tests with different amount of oat polar lipid fraction (0,1%; 0,25%; 0,5% or 1%) and varying oil : water compositions (1 – 10% of oil) an Ultra-Turrax[®] T 25 Digital disperser with a S 25 N – 10 G dispersing tool (IKA[®], Germany) was used for homogenization with a speed of 24 000 rpm for 5 minutes. For larger scale homogenization, a pre-emulsion was made with a magic LAB[®] dispersing system with micro-plant assembly and 6F blade (IKA[®], Germany) with a speed of 16 000 rpm for 2,5 minutes twice. The pre-emulsion was then fed three times through a FT 9 high pressure homogenizer (Armfield, USA) operating at a pressure of 50 bars.

Some of the emulsions (0,5% of oat polar lipid fraction, 1 or 2% of oil containing lutein) were spray-dried with a Mini Spray Dryer B290 (Büchi, Germany). Before spray-drying, 30% of maltodextrin with DE 16,5-19,5 was mixed to the emulsions to act as wall material. The drying conditions were as follows: inlet temperature 150

°C, outlet temperature 80 °C, air flow 450 l/h, feed flow 7 ml/min, aspirator 37 m³/h and nozzle orifice 1,50 mm.

Emulsion stability was evaluated by storing the emulsions in room temperature protected from light and observing the changes in the visual appearance, notably creaming of emulsions and colour of emulsions made with oil containing lutein. A light microscope equipped with digital camera was used to determine changes in droplet size during storage.

RESULTS AND DISCUSSION

Regardless of the many different oil : water compositions and amounts of oat polar lipid fraction tested, all the emulsions showed significant creaming after only a few days. Most of the emulsions separated into three layers: on top was a narrow cream layer, in the middle was an opaque, turbid, milk-like emulsion layer and at the bottom was almost transparent aqueous layer. Despite the evident instability of the emulsions, we also made some very encouraging observations. Based on microscopic observations, the droplet size of emulsions is in the range of 1 – 5 µm. Emulsions containing 0,5% or 1% of oat polar lipid fraction showed only little coalescence, since even after allowing the cream layer to stand for one month the droplet size hadn't changed much. This means that the cream layer can easily be redispersed into emulsion with simple mixing. On the other hand, emulsions with 0,25% of oat polar lipid fraction showed remarkable coalescence after two weeks. These results imply that the amount of emulsifier has great influence on the emulsion stability against coalescence.

Emulsions made with oil containing lutein were yellow in colour. After creaming, most of the colour was in the topmost cream layer, but the bulk emulsion was also slightly yellow. The intensity of colour was positively correlated with the amount of oil in the emulsion, and negatively correlated with the amount of oat polar lipid fraction in the emulsion. The first relation is quite obvious, since larger amount of oil also means larger amount of lutein. The latter relation implies that the thickness of emulsifier layer changes with the amount of emulsifier used. This could also explain why the amount of emulsifier affects stability against coalescence.

Spray drying conditions were chosen according to our previous studies of 30 % maltodextrin solutions. Most of the product was found in the collector, but also some was collected from the walls of the spray cylinder. Water

content of both collected products was, however, similar, 4-6 % depending on the emulsion composition (measured by drying overnight in an oven at 100 °C). When redispersed in water in a test tube with vortex mixing, the dried product formed an emulsion very similar with the same emulsion before drying. The speed and extent of creaming was quite similar with the emulsion before spray-drying, but the creamed oil phase showed some coalescence after only a couple of days.

We also tested the effect of added maltodextrin on emulsion stability without spray-drying using 0,25% of oat polar lipid fraction and 1% of oil. It seems that 30% of maltodextrin greatly increases the rate and extent of creaming. After two weeks, an emulsion with maltodextrin was creamed to a practically clear, transparent water phase with a sharp oil ring on top, whereas an emulsion prepared at the same time without maltodextrin but otherwise equal was still opaque, milk-like emulsion with only a faint oil ring on top. Moreover, the oil layer of the emulsion containing maltodextrin was in a way solidified, and it couldn't be redispersed into emulsion with simple mixing unlike the emulsion without maltodextrin.

CONCLUSIONS

Oat polar lipid fraction seems to be a promising emulsifier for O/W emulsions, mainly because in sufficient amounts it seems to inhibit coalescence. Creaming of emulsions is generally a smaller problem than coalescence, because it's easier to prevent, for example by reducing droplet size. Different methods for homogenization should probably be tested in an attempt to produce emulsions with smaller droplet sizes. For preparation of coloured emulsions, some compromises have to be made regarding the amount of emulsifier used to find a suitable balance between coalescence resistance and perceived colour.

It seems that these emulsions can be spray-dried for easier storage (solid vs. liquid), and the dried product seems to produce a same kind of emulsion when redispersed in water. Obviously further studies are needed to ensure storage capability of the dried emulsions and also to see if the drying process affects the properties and stability of the redispersed emulsions. One difficulty for spray-drying is that adding maltodextrin to the emulsions seems to reduce their resistance against coalescence.

REFERENCES

Aro H. et al. (2007) *The Characterisation of Oat Lipids Produced by Supercritical Fluid Technologies*. Journal of Cereal Science 45 116-119