TABLE 14

Free fat analysis of powders with secondary coating

| MCT coat addition (% w/w) | Powder Free Fat (g/100 g) |
|---|---|
| 0 | 8.9 |
| 1 | 9.8 |
| 2 | 11.0 |
| 4 | 12.1 |

## CONCLUSION

The formulation and preparation of oil-in-water emulsions, is the most important step in the successful production of microencapsulated fats and oil in emulsions or powders.

Very low powder free fat in tuna oil powders even at high oil loading has been achieved with the use of mixed protein-carbohydrate encapsulants. The mixed systems (protein-carbohydrate) investigated using Na-caseinate or whey protein isolate (WPI) in combination with sugars (glucose, sucrose, lactose, dried glucose syrup and oligosaccharide), and in some cases with polysaccharide (carrageenan or High-methoxy pectin) gave good powders. Powders formulated with heated NaCas-sugar mixtures were generally more resistant to oxidation compared to those made from unheated mixtures.

Other general conclusions are:

- Dry free flowing powder with oil loading up to 80% may be successfully produced with the appropriate choice of encapsulants.
- Increased level of sugars lowers the powder free fat, but also reduces powder recovery during drying. Thus the level of sugars has to be carefully chosen to ensure adequate powder recovery during production whilst achieving low powder free fat.
- Generally a lower total solids at the time of homogenisation lowers the powder free fat.
- In mixed protein and carbohydrate systems a protein: carbohydrate ratio of 1:2 is better than a ratio of 1:1, which was demonstrated by lower powder free fat and better protection of the oil from oxidation.
- Heating all the caseinate and sugars of the aqueous phase by refluxing or heating at 90° C. for 30 minutes afforded better protection to powders against oxidation, than heating only part of the caseinate and part of the sugar used in the system.
- In heated casein-sugar systems refluxing the mixture for 30 minutes afforded better protection to powders against oxidation, than heating at 90° C. for 30 minutes.
- The pH of the of the casein-sugar mixture at the time of heating has significant effects on both the powder free fat and the resistance of the powder to oxidation during storage; with heating at the higher pH of 7.5 being better than heating at pH 7 or at pH 6.5
- The type of sugar used in combination with the protein has also some effect on the degree of protection from oxidation it can offer during powder storage.
- At least about 10% of the sugar in the sugar protein mixtures should be reacted to obtain desirable levels of anti-oxidant protection

The invention claimed is:

**1**. A method of forming a powder containing a polyunsaturated oil comprising:

a) preparing an aqueous mixture of a water soluble film forming protein and a carbohydrate which contains a reducing sugar group;

b) heating the mixture from 60° C. to 160° C. for a period to allow sufficient Maillard reaction products to form without coagulation consuming at least 10% of the sugar to provide resistance to oxidation;

c) dispersing said oil in the aqueous phase;

d) homogenising the mixture to obtain an emulsion; and

e) drying the emulsion to form a powder,

wherein the polyunsaturated oil is selected from the group consisting of canola oil, borage oil, evening primrose oil, safflower oil, sunflower oil, flaxseed oil, wheat germ oil, grape seed oil, marine oils obtained from fish, vitamin A, vitamin D, vitamin E, tocopherols, tocotrienols, vitamin K, and beta-carotene.

**2**. A method of forming a powder containing a polyunsaturated oil as claimed in claim **1**, wherein at least some of the carbohydrate is added after the emulsion is formed and step b) is carried out after step d) but before step e).

**3**. A method of forming a powder containing a polyunsaturated oil as claimed in claim **1**, wherein the total solids at homogenisation is less than 50% and the protein:carbohydrate weight ratio is between 1:4 and 4:1.

**4**. A method of forming a powder as claimed in claim **1**, wherein the water soluble protein is selected from milk proteins and soy proteins.

**5**. A method of forming a powder as claimed in claim **4**, wherein the milk protein is selected from whey proteins and casein.

**6**. A method of protecting a polyunsaturated oil from degradation comprising:

a) preparing an aqueous mixture of a water soluble film forming protein and a carbohydrate which contains a reducing sugar group;

b) heating the mixture from 60° C. to 160° C. for a period to allow sufficient Maillard reaction products to form without coagulation consuming at least 10% of the sugar to provide resistance to oxidation;

c) dispersing said oil in the aqueous phase; and

d) homogenising the mixture to obtain an emulsion,

wherein the polyunsaturated oil is selected from the group consisting of canola oil, borage oil, evening primrose oil, safflower oil, sunflower oil, flaxseed oil, wheat germ oil, grape seed oil, marine oils obtained from fish, vitamin A, vitamin D, vitamin E, tocopherols, tocotrienols, vitamin K, and beta-carotene.

**7**. The method of claim **6**, further comprising drying the emulsion to form a powder.

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