

ELEMENTIS

SPECIALTIES

# A Comparison of Meadowfoam Seed Oil and Jojoba Oil





# Introduction

Oils are one of the most common groups of materials used in the personal care industry. They provide emolliency, to impart protection to the skin while also giving good lubrication and a positive feel to the skin. They can help provide consistency to the texture of products and also help to replace the oils found in the skin that may have been lost through the use of harsh cleansing preparations.

Natural oils are essential ingredients for formulation chemists. Plant oils are esters of glycerin and fatty acids which form triglycerides. Natural oils can also contain various smaller components, such as free fatty acids, phospholipids, tocopherols and hydrocarbons.

Jojoba Oil was initially introduced in the 1970's to replace Sperm Whale Oil and its derivatives in the cosmetic and personal care industries.

Structurally, Jojoba Oil shows similarities to the human skin oil (sebum). It is therefore speculated that applying Jojoba Oil to the skin may send a biological message that the skin has produced enough sebum, thus balancing oil production.

Jojoba Oil is actually a liquid wax ester and not an oil. It is a natural emollient with good spreadability and can be used to provide a protective coating on the skin. It is also useful as a hair conditioning agent.

Although Jojoba Oil has many benefits for the consumer, it is not without disadvantages. Jojoba Oil is very expensive. It can cost a third more than Meadowfoam Seed Oil and the supply can become restricted. For this reason, we have evaluated the use of Meadowfoam Seed Oil as an alternative to Jojoba Oil.

# Jojoba and Meadowfoam Plants

*Simmondsia Chinensis* is an evergreen, drought resistant shrub, commonly known as Jojoba, which is native to Arizona, California and Mexico. (See Figure 1) It can grow to between 0.6—5 meters high and the roots can become up to 10 meters long, with thinly shelled nuts as fruit. Jojoba is deoecious (has male and female reproductive plants). The jojoba shrub has a life span of 100-200 years.

The jojoba shrub is ready to produce fruit approximately 3-5 years after being sown. This process takes another 6-7 months in dry conditions for the nuts to become ripe enough to harvest in September-October each year thereafter.

After 5 years, each jojoba shrub yields 400-500g of nuts. After 12 years, this increases to 2-4kg of nuts and after 25 years, a jojoba shrub can produce 13kg of nuts.



Figure 1. Jojoba Shrub and Fruit



Figure 2. Meadowfoam plant

*Limnanthes Alba* is a flowering plant commonly known as meadowfoam (See figure 2). It is a herbaceous winter plant, which means that it has a soft green stem and all of its parts above ground level die after it has finished growing. It is native to Oregon, where it preferentially grows in moist environments. It is an annual plant which can grow to 30cm tall and the petals on the flowers can become 1-1.5cm long.

The seeds of the meadowfoam plant, seen in Figure 3, are about 3mm in diameter and contain 20-30% meadowfoam seed oil, whereas the nuts of the jojoba shrub, seen in Figure 4, are about 12mm long and contain about 48-56% jojoba oil.



# Jojoba and Meadowfoam Seed Oil Processing

FANCOR<sup>®</sup> Meadowfoam Seed Oil is removed from the *Limnanthes Alba* (Meadowfoam) seed using a mechanical crushing process. Elementis Specialties does not use an external heat source to aid in the process. The product is then neutralized, lightened in color and deodorized in order to produce the final refined Meadowfoam Seed Oil. Unlike other oils, FANCOR<sup>®</sup> Meadowfoam Seed Oil is not produced via solvent extraction, so it is a natural product which has been refined in a natural way. This green processing method has enabled Elementis Specialties to conform to the Ecocert standard for FANCOR<sup>®</sup> Meadowfoam Seed Oil.

Jojoba Oil can be made through either the solvent extraction process or cold pressing process like FANCOR<sup>®</sup> Meadowfoam Seed Oil. Some grades of Jojoba Oil conform to the Ecocert standard, but not all.

Jojoba Oil INCI: *Simmondsia Chinensis* (Jojoba) Seed Oil

FANCOR<sup>®</sup> Meadowfoam Seed Oil INCI: *Limnanthes Alba* (Meadowfoam) Seed Oil



Figure 3. Meadowfoam Seed



Figure 4. Jojoba Seed

# Jojoba and Meadowfoam Seed Oil Composition

Jojoba Oil is composed of different wax esters of C<sub>18-22</sub> Omega-9 fatty acid (985) with a fatty alcohol. FANCOR<sup>®</sup> Meadowfoam Seed Oil has a unique structure comprised of approximately 95% of C<sub>20-22</sub> fatty acids.

The typical fatty acid profiles of Jojoba Oil and Meadowfoam Seed Oil are as follows:

	Jojoba Oil	Meadowfoam Seed Oil
Oleic Acid C18:1	14 %	-
Eicosenoic Acid C20:1	70 %	61%
Docosenoic Acid (Erucic Acid) C22:1	16 %	16 %
Docosadienoic Acid C22:2	-	18 %

Table 1. Fatty Acid composition of Jojoba Oil and Meadowfoam Seed Oil

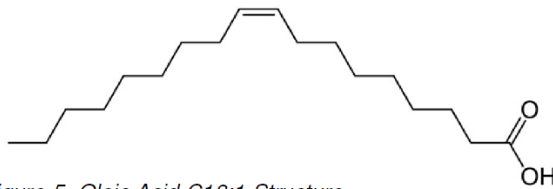


Figure 5. Oleic Acid C18:1 Structure

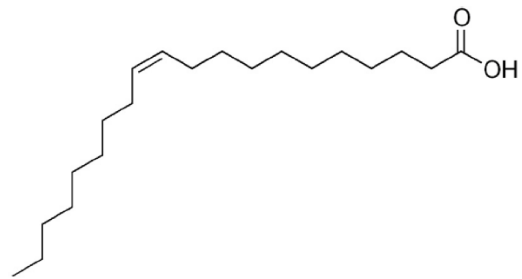


Figure 6. Eicosenoic Acid C20:1 Structure

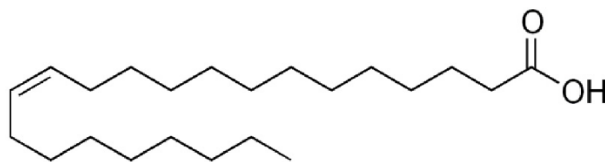


Figure 7. Docosenoic Acid (Erucic Acid) C22:1 Structure

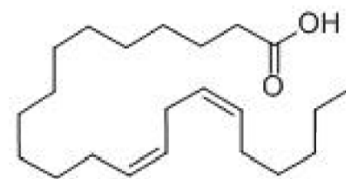


Figure 8. Docosadienoic Acid C22:2 Structure

From this direct comparison above, we can see that Jojoba Oil and Meadowfoam Seed Oil have similar levels of the various fatty acids. The main difference is that Jojoba Oil contains the C18 fatty acid (Oleic Acid) whereas Meadowfoam Seed Oil contains the C22 fatty acid (Docosadienoic Acid). The result is a very similar skin feel.

# Methodology for Determining the Oxidative Stability Index

The Oxidative Stability Index (OSI) determines the relative resistance of an oil to oxidation. Most oils are prone to oxidation and the speed at which this happens depends on the degree of unsaturation in the product and the presence of any antioxidants.

The Oxidative Stability Index was determined using the oxidative stability instrument manufactured by Omnion, as seen in Figure 9, using the American Oil Chemists' Society (AOCS) official method number Cd 12b-92

The temperature is set at 130°C. A stream of air is passed through the oil in the sealed test tube and then passed into another sealed test tube containing distilled water, as shown in Figure 10. The conductivity of the water is constantly monitored. During the test the conductivity of the water remains consistent until a sudden increase is measured. This value in hours is recorded as the Oxidative Stability Index.



Figure 9 Omnion Oxidative Stability Instrument

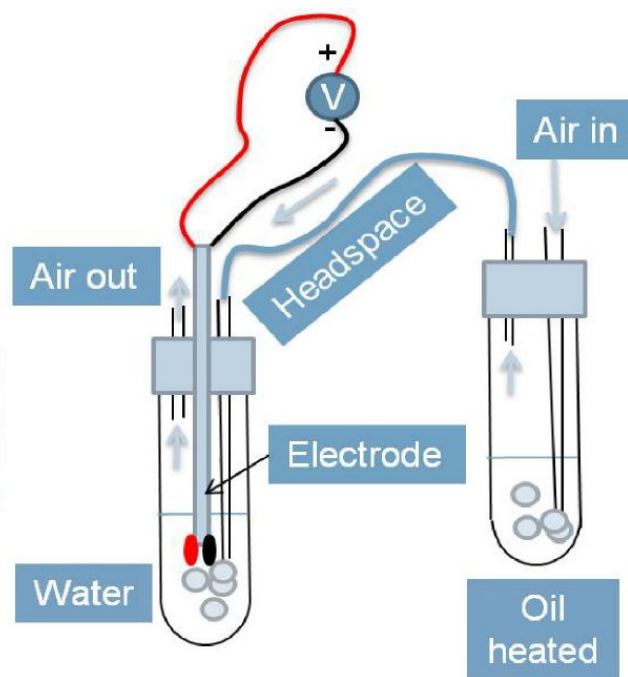


Figure 10. Oxidative stability testing process

# Oxidative Stability Index Comparison

Meadowfoam seed oil is the most stable vegetable oil in the world. It contains powerful natural antioxidants and most importantly, the unsaturated double bonds on the fatty acids are located at the  $\Delta 5$  and  $\Delta 13$  position. The lack of conjugated double bonds and natural antioxidants delivers extraordinary oxidative stability, thus making it resistant to heat breakdown and oxidation.

Meadowfoam seed oil is a highly stable oil from nature and will extend the shelf life of less stable ingredients when added to the system.

When tested at 130°C, meadowfoam seed oil has an average oxidative stability of 15 hours, whereas jojoba oil only has an Oxidative Stability Index of 9.5 hours (Figure 11).

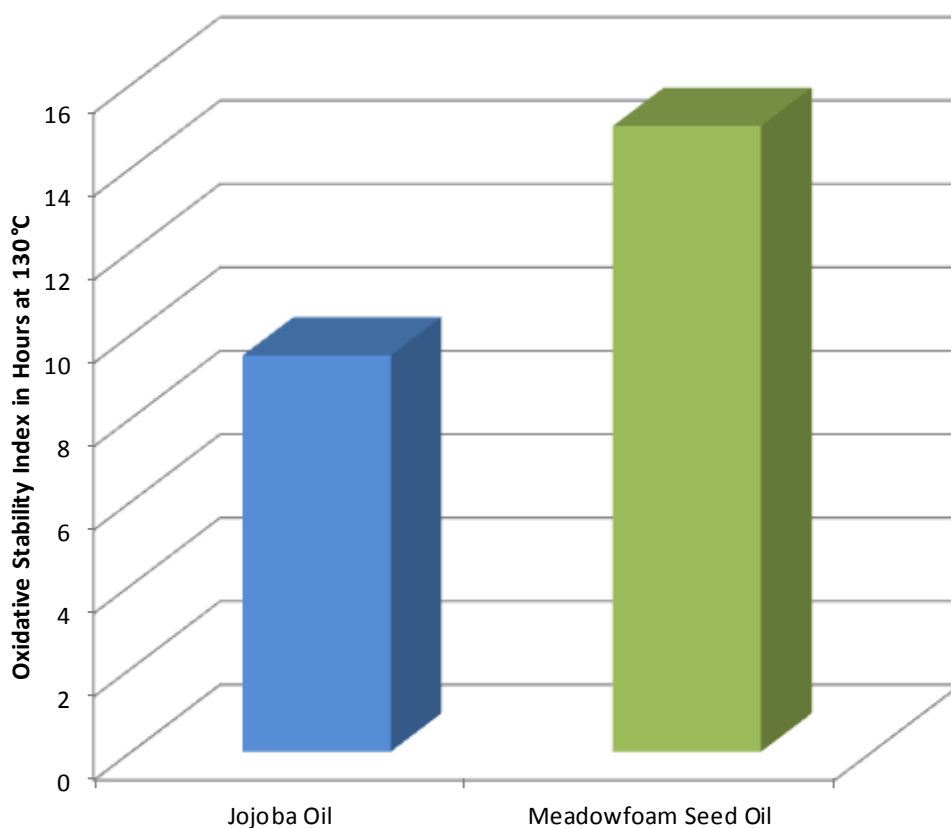


Figure 11. Oxidative Stability Index comparison of Meadowfoam Seed Oil and Jojoba Oil



# Jojoba Oil and Meadowfoam Seed Oil Appearance

Jojoba Oil is a wax ester with a melting point of 7°C, which means that it is liquid at room temperature. Jojoba Oil can come in various shades, but it is most commonly clear and yellow (Figure 12).

FANCOR® Meadowfoam Seed Oil is a slightly golden colored clear liquid oil, even though it has a high molecular weight. Meadowfoam seed oil tends to be lighter than jojoba oil.

Flowcurves of the individual oils were measured using a Paar Physica MCR 300 Rheometer. The flowcurves, seen in Figure 13, show that the meadowfoam seed oil has a slightly higher viscosity than jojoba oil. This is probably due to the higher carbon chain fatty acids in meadowfoam seed oil.

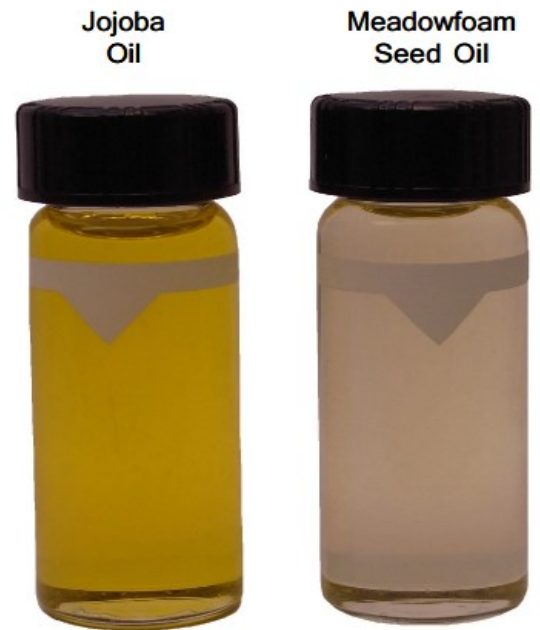


Figure 12. Comparison of appearance of jojoba oil and meadowfoam seed oil

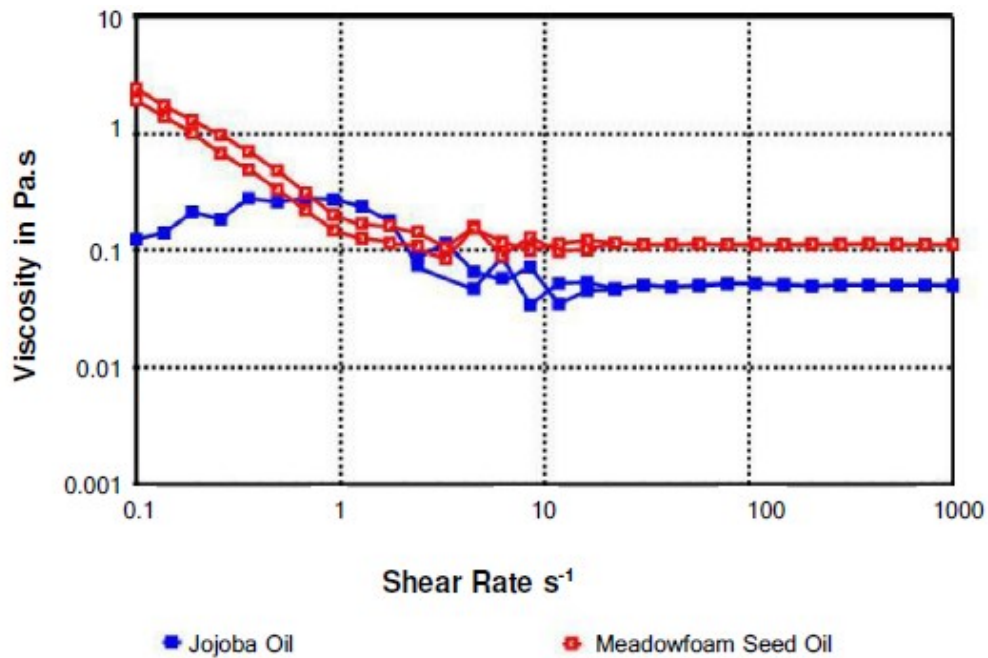


Figure 13. Flowcurve comparison of jojoba oil and meadowfoam seed oil

# Skin Feel Test Method

To measure the skin feel of jojoba oil and meadowfoam seed oil, a Thwing-Albert Friction/Peel Tester was used. The oils were each applied to 2 pieces of paper with a film thickness of 30  $\mu\text{m}$  and left to dry. One piece of the paper was cut to the same size as the sled and attached to the apparatus. The coefficient of friction was measured using the friction/peel tester, with a stroke length of 50mm at 0.125Hz with an applied load of 2N.



Figure 14. Thwing-Albert Friction/Peel Tester Model 225-1

## Coefficient of Friction Comparison

The results of the coefficient of friction testing showed that jojoba oil produces a coefficient of friction of 0.07 and meadowfoam seed oil gave a coefficient of friction of 0.2.

This is reinforced by the feel of the individual oils when applied to the skin. As we have seen previously, jojoba oil and meadowfoam seed oil have similar levels of the two fatty acids, Eicosenoic Acid and Docosenoic Acid (Erucic Acid). The difference appears in the third main fatty acid in each oil. Jojoba oil contains the C<sub>18</sub> fatty acid, Oleic Acid, whereas meadowfoam seed oil contains the C<sub>22</sub> fatty acid, Docosadienoic Acid.

This gives both oils a similarly smooth application on the skin, with the meadowfoam seed oil offering a slightly richer feel. This is shown in the results for the coefficient of friction in Figure 15. The higher coefficient of friction is attributed to the longer chain fatty acid in meadowfoam seed oil.

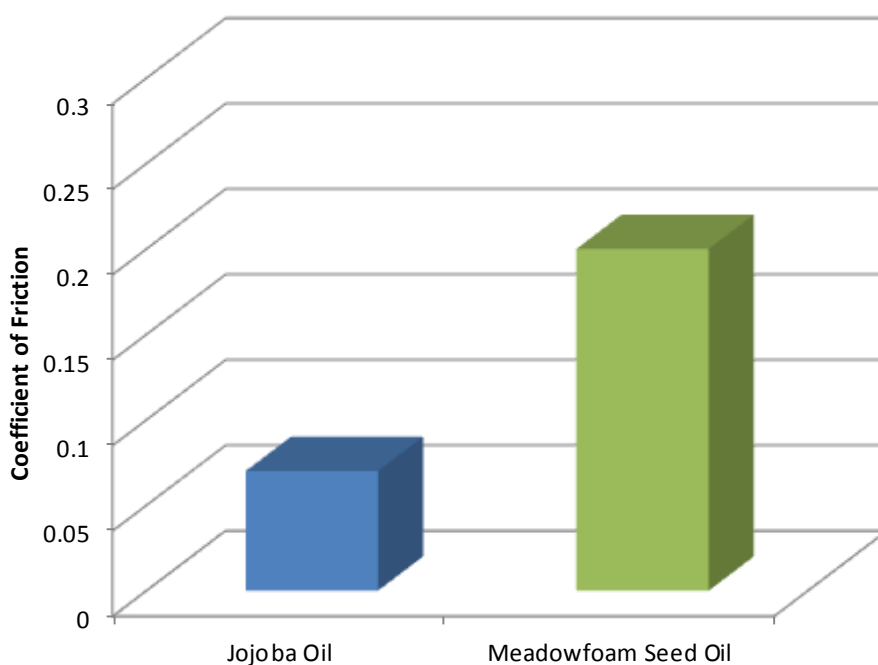


Figure 15. Coefficient of Friction of Meadowfoam Seed Oil and Jojoba Oil

# Formulation Comparison

Various formulation concepts were evaluated comparing FANCOR<sup>®</sup> Meadowfoam Seed Oil and jojoba oil.

## Formula 1: Skin Lotion

Ingredients	Supplier	Formula 1	Formula 2
Phase A		%w/w	%w/w
Deionized Water		75.50	75.50
Phase B			
FANCOR <sup>®</sup> Meadowfoam Seed Oil (Limnanthes Alba (Meadowfoam) Seed Oil)	ELEMENTIS Specialties	16.00	-
Simmondsia Chinensis (Jojoba) Seed Oil		-	16.00
BENTONE GEL <sup>®</sup> VS-5PC V (Cyclopentasiloxane (and) Distearidimonium Hectorite (and) Propylene Carbonate)	ELEMENTIS Specialties	2.00	2.00
Tegosoft DEC (Decyl Cocoate)	Evonik	3.00	3.00
Abil EM 90 (Cetyl PEG/PPG-10/1 Dimethicone)	Evonik	2.00	2.00
White Beeswax (Beeswax)	Strahl & Pitsch	0.50	0.50
Phase C			
Germaben II (Propylene Glycol (and) Diazolidinyl Urea (and) Methylparaben (and) Propylparaben)	Ashland	1.00	1.00
Total		100.00	100.00

## Procedure:

1. Heat Phase A to 70-75°C.
2. Combine Phase B and heat to 70-75°C.
3. Add Phase B to Phase A with high shear mixing (i.e. Silverson Homogenizer)
4. Cool with propeller stirring
5. At 45°C, add Phase C and mix until homogenous.

# Formula 1: Skin Lotion Panel Testing

Panel testing was carried out to evaluate the various properties of the skin lotions with FANCOR<sup>®</sup> Meadowfoam Seed Oil and jojoba oil. Ten volunteers were given samples of both lotions to test and evaluate. The lotions were labeled A and B. Lotion A contained jojoba oil and Lotion B contained FANCOR<sup>®</sup> Meadowfoam Seed Oil. Panelists were asked to apply a small amount of Lotion A to the left hand, using three fingers to spread it and apply a small amount of Lotion B to the right hand, again using three fingers to spread the lotion. This was to be repeated every time the panelist washed their hands until the lotion was finished. Panelists used the lotions at least three times per day. They were then asked to fill in the following questionnaire:

<p>QUESTION 1: For <b>appearance</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A and B are very different.</li><li>b. A and B are only slightly different.</li><li>c. A and B are indistinguishable.</li></ul>	<p>QUESTION 4: For <b>shine</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A has much more shine than B.</li><li>b. B has much more shine than A.</li><li>c. A has slightly more shine than B.</li><li>d. B has slightly more shine than A.</li><li>e. A and B are indistinguishable.</li></ul>	<p>QUESTION 7: <b>Overall</b>, which best describes your perception of the lotions?</p> <ul style="list-style-type: none"><li>a. A is much better than B.</li><li>b. B is much better than A.</li><li>c. A is slightly better than B.</li><li>d. B is slightly better than A.</li><li>e. A and B are indistinguishable.</li></ul>
<p>QUESTION 2: For <b>stickiness</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A is much stickier than B.</li><li>b. B is much stickier than A.</li><li>c. A is slightly stickier than B.</li><li>d. B is slightly stickier than A.</li><li>e. A and B are indistinguishable.</li></ul>	<p>QUESTION 5: For <b>skin softness</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A is much softer than B.</li><li>b. B is much softer than A.</li><li>c. A is slightly softer than B.</li><li>d. B is slightly softer than A.</li><li>e. A and B are indistinguishable.</li></ul>	<p>Comments:</p>
<p>QUESTION 3: For <b>drag</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A has much more drag than B.</li><li>b. B has much more drag than A.</li><li>c. A has slightly more drag than B.</li><li>d. B has slightly more drag than A.</li><li>e. A and B are indistinguishable.</li></ul>	<p>QUESTION 6: For <b>skin moisturisation</b>, what do you feel?</p> <ul style="list-style-type: none"><li>a. A is much better than B.</li><li>b. B is much better than A.</li><li>c. A is slightly better than B.</li><li>d. B is slightly better than A.</li></ul>	



# Formula 1: Skin Lotion Panel Testing Results

The results of the panel testing were compiled and graphed for reference. We can see by the graphs that the participants found it difficult to distinguish between the lotion containing jojoba oil and the lotion containing FANCOR® Meadowfoam Seed Oil.

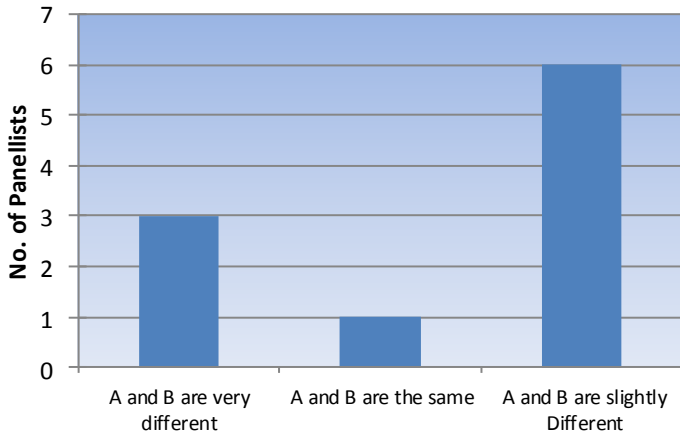


Figure 18. Assessment of formula appearance

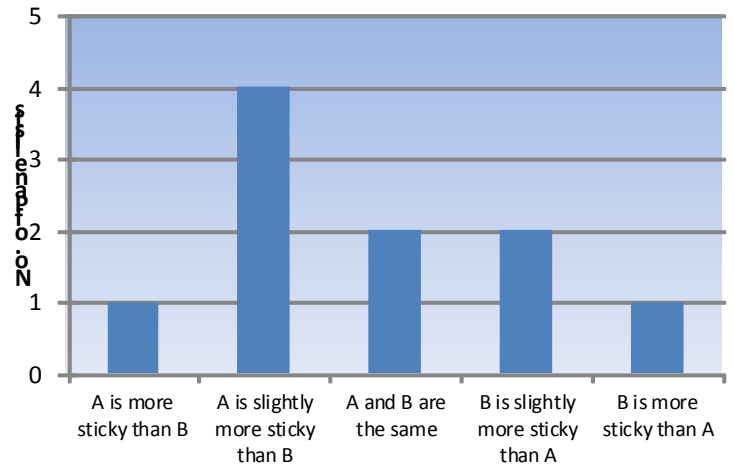


Figure 19. Assessment of stickiness

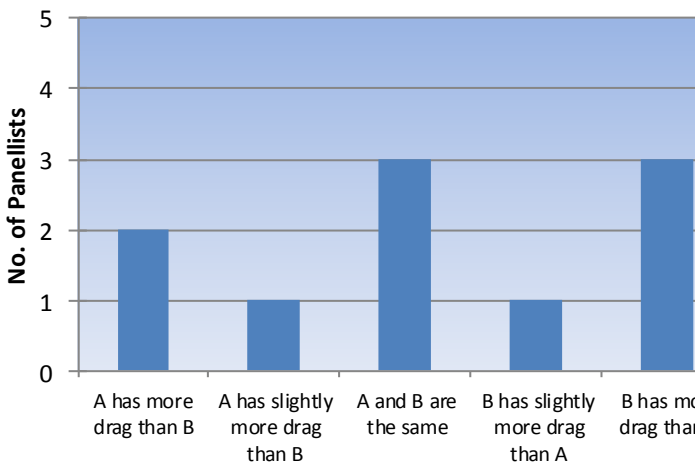


Figure 20. Assessment of drag

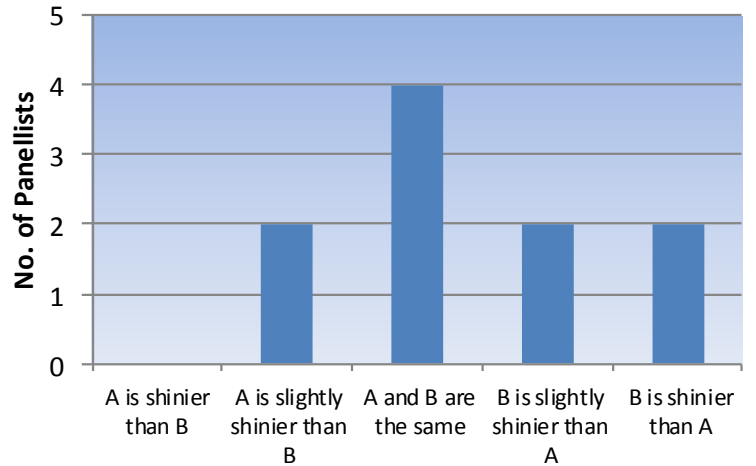


Figure 21. Assessment of shine

# Formula 1: Skin Lotion Panel Testing Results

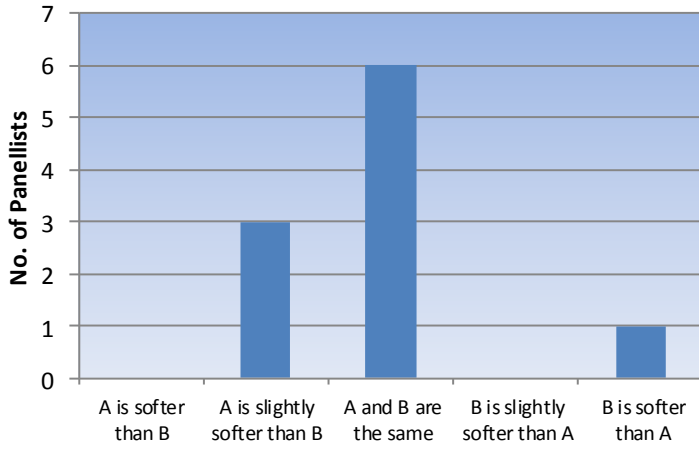


Figure 22. Assessment of skin softness

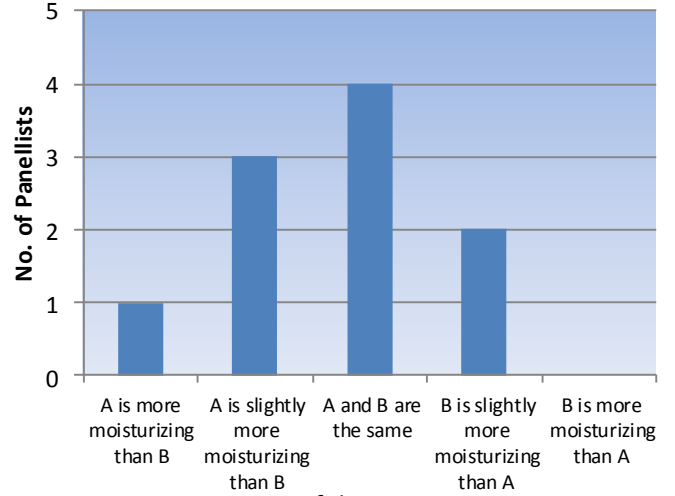


Figure 23. Assessment of skin moisturization

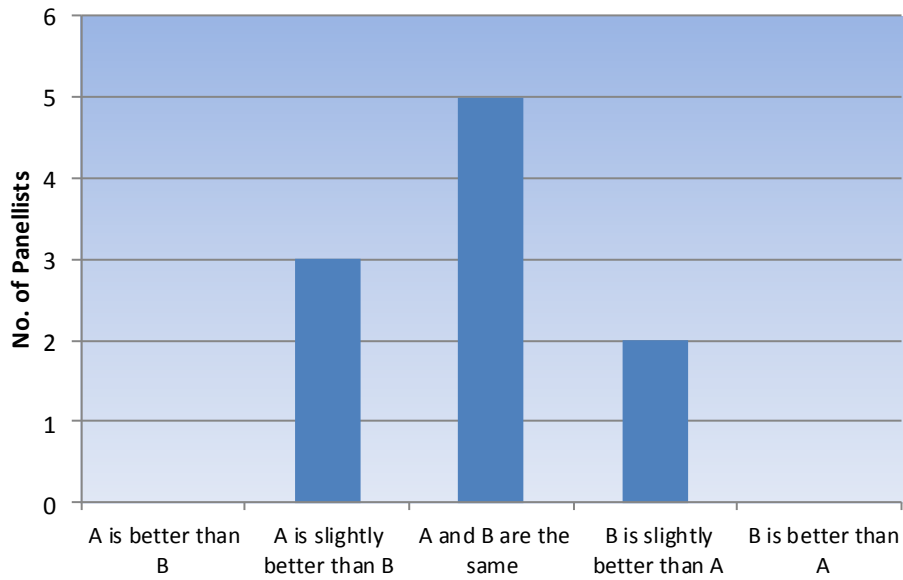


Figure 24. Overall assessment of the skin lotions

# Formulation Comparison

## Formula 2: Sunscreen Oil Spray

Ingredients	Supplier	Formula 1	Formula 2	Control
Phase A		%w/w	%w/w	%w/w
FANCOR® Meadowfoam Seed Oil (Limnanthes Alba (Meadowfoam) Seed Oil)	ELEMENTIS Specialties	11.00	-	-
Simmondsia Chinensis (Jojoba) Seed Oil		-	11.00	-
Cyclopentasiloxane		66.50	66.50	77.50
Eusolex OCR (Octocrylene)	Azelis	10.00	10.00	10.00
Eusolex 2292 (Ethylhexyl Methoxycinnamate (and) BHT)	Azelis	7.50	7.50	7.50
Eusolex OS (Ethylhexyl Salicylate)	Azelis	5.00	5.00	5.00
Total		100.00	100.00	100.00

### Procedure:

1. Combine Phase A and mix until clear and uniform.

## Formula 2: Sunscreen Oil Spray Comparison

In Figure 25, we can see the sunscreen oil spray formula prepared with either meadowfoam seed oil, jojoba oil or neither oil. They have a very similar appearance and aesthetic properties.



**Sunscreen Oil  
Spray Control**



**Sunscreen Oil Spray  
with Jojoba Oil**



**Sunscreen Oil Spray  
with Meadowfoam  
Seed Oil**

Figure 25. Appearance of sunscreen oil sprays



## Formula 2: Sunscreen Oil Spray Comparison

Flowcurves were measured for each of the sunscreen oil sprays. No perceivable difference was observed, as seen in Figure 26.

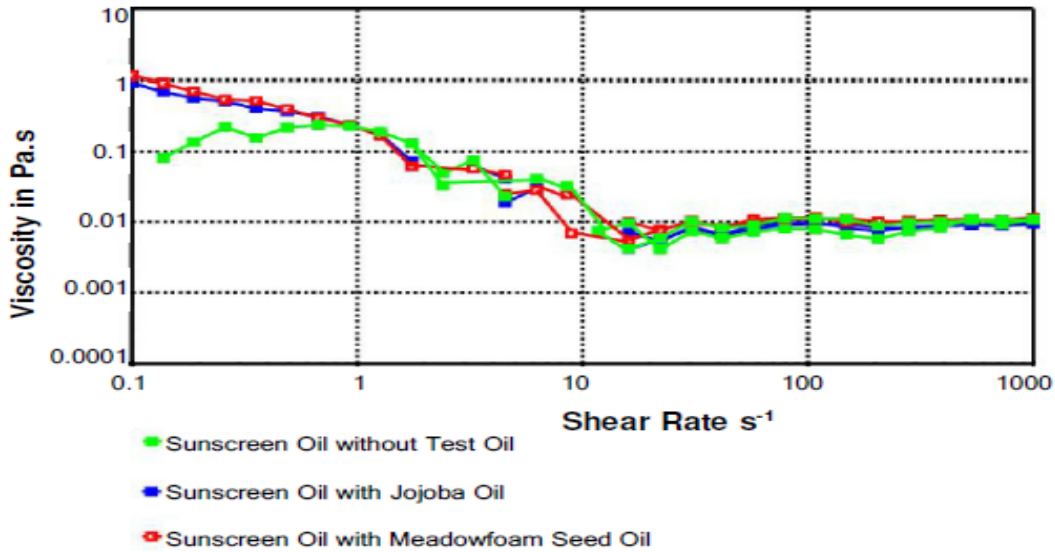


Figure 26. Flowcurves of sunscreen oil sprays

The coefficient of friction was measured for the sunscreen oil sprays to assess the skin feel. In Figure 27, we can see that there is hardly any difference between the sunscreen oil spray with jojoba oil and the sunscreen oil spray with meadowfoam seed oil.

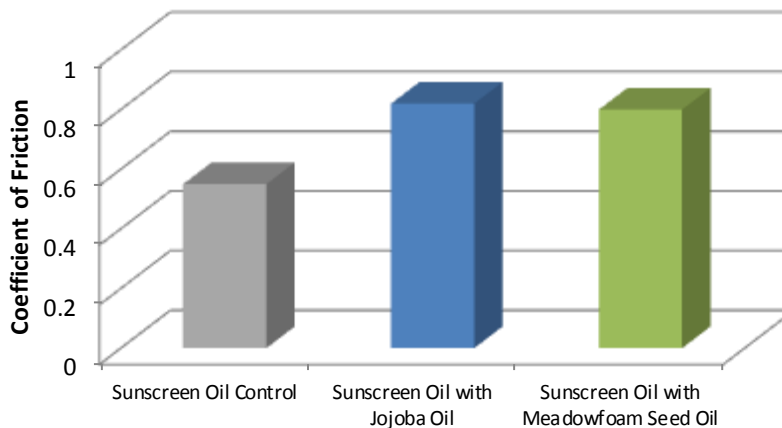


Figure 27. Coefficient of Friction comparison of sunscreen oil sprays



# Formulation Comparison

## Formula 3: Lipstick

Ingredients	Supplier	Formula 1	Formula 2	Control
Phase A		%w/w	%w/w	%w/w
FANCOR® Meadowfoam Seed Oil (Limnanthes Alba (Meadowfoam) Seed Oil)	ELEMENTIS Specialties	25.00	-	-
Simmondsia Chinensis (Jojoba) Seed Oil		-	25.00	-
Ricinus Communis (Castor) Seed Oil		30.80	30.80	55.80
Koster Keunen Candelilla Wax (Euphorbia Cerifera (Candelilla) Wax)	Koster Keunen	7.00	7.00	7.00
Microcrystalline Wax		3.00	3.00	3.00
Koster Keunen Carnauba Wax (Copernicia Cerifera (Carnauba) Wax)	Koster Keunen	2.00	2.00	2.00
Ozokerite		2.00	2.00	2.00
Tocopheryl Acetate		0.10	0.10	0.10
Propylparaben		0.10	0.10	0.10
Phase B				
Ricinus Communis (Castor) Seed Oil		15.00	15.00	15.00
Red 7 Lake		3.00	3.00	3.00
Red 6 Lake		1.00	1.00	1.00
Red 33 Lake		1.00	1.00	1.00
Phase C				
Talc		10.00	10.00	10.00
Total		100.00	100.00	100.00

### Procedure:

1. Combine Phase A and mix until clear and heat to 85°C.
2. Mill Phase B and add to Phase A. Mix until uniform.
3. Add Phase C and mix until uniform.
4. Pour into mold and cool.

## Formula 3: Lipstick Comparison

In Figure 28, we can see lipsticks which were made using meadowfoam seed oil, jojoba oil or neither oil. The lipstick with jojoba oil yielded a slightly harder stick. The lipstick prepared with meadowfoam seed oil gave a smoother appearance on the surface of the stick and also improved the release of the lipstick from the mold. The lipstick with meadowfoam seed oil also gave the most shine.



Figure 28. Appearance of lipsticks without test oil, with jojoba oil and with meadowfoam seed oil

# Summary

FANCOR® Meadowfoam Seed Oil is a good, high quality, yet more economic alternative to jojoba oil. As meadowfoam seed oil is an annual crop that is planted each year and yields seeds within months. It is a more reliable oil source than jojoba, which needs an initial growth period of 5 years before the seeds are produced which yield the oil.

## Highlights of study results

### Similar Fatty Acid Composition

- Although Jojoba Oil is a liquid wax ester the composition of the fatty acids in comparison to FANCOR® Meadowfoam Seed Oil have significant similarities.

### Improved Oxidative Stability

- The determination of the Oxidative Stability Index (OSI) reveals Meadowfoam Seed Oil as being the most stable oil against oxidation due to its unsaturated double bonds in position D5 and D13 and a natural antioxidant.

### Similar Formulation Characteristics

- Panel testing showed a high indistinguishability of a skin lotion containing 16% Jojoba Oil (formulation A) or 16% FANCOR® Meadowfoam Seed Oil (formulation B).
- In a sunscreen oil, the physical and aesthetic properties were nearly identical.

Before using any of our products, please consult our Safety Data Sheets.

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