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Changes of fats in germinating hemp



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PART I.

Classification of food from perspective of nutrient availability

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This presentation has 3 parts. In the first one we will talk about Classification of food from perspective of nutrient availability

In the second part we'll discuss properties of fats and their digestion and in the last part we will present our preliminary results in germinating hemp seed

What are we eating... ...and trying to digest?



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Probably not everybody knows that the greens surrounding us contain tremendous amount of omega oils. The dry material of green grass like wheat or barley contains 5% fat. However this fat has around 65-70% ALA, omega-3 fatty acid.

The dumb animals are eating this green mass, we clever people, are eating the concentrates – the grains having no omega-3 fatty acids.

What are we eating... ...and trying to digest?

- Most of our foods are made from **dormant** seeds
- These propagating units are made **not to feed us**, but to **save transfer** of genetic information for the next generations
- Plants have built up several **protection systems** to prevent their propagating units. This protection can be physical or chemical: toxins, enzyme inhibitors, tannins, phytic acids, etc.
- When we are starting to utilize the seed as nutrient, these protecting mechanisms are acting as **anti-nutritive** materials in our foods, which make them difficult to digest and utilize.

What are we eating... ...and trying to digest?

- Because these anti-nutritive materials are present also in the processed food, up to 80% of the nutrient content can not be utilized by the human and animal organisms
- A **large** amount of the nutritional material produced by the agriculture is **lost** because of the **improper understanding** and **processing** of the foods
- Now imagine how serious this situation gets with raising human population and ongoing climate change

What are we eating... ...and trying to digest?

- Nutrients in seeds are stored in form of giant **molecules** in a highly condensed form - like a ZIP file in the computer
- The basic goal of our digestion is to **break down** these molecules in order to:
 - ✓ make them utilizable for our organism
 - ✓ brake down the several anti-nutritive materials

Paradigm shift

Modern technology **can** handle **industrial-scale germination** to serve changing consumer habits.

Germinated seeds:

- **break down** the anti-nutritive components in the seeds
- **new enzyme** and **vitamin synthesis** are triggered
- nutritional material is **biochemically changed - predigested**
- active (**functional**) ingredients are released and these active materials are **becoming 100% biologically available!**

PART II.

Fat and fat digestion

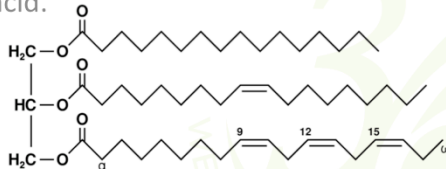
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What is fat?

- Most of the “food fat” comes in a form of **triglyceride (TAG)** which is formed by one glycerol molecule and three molecules of fatty acid.

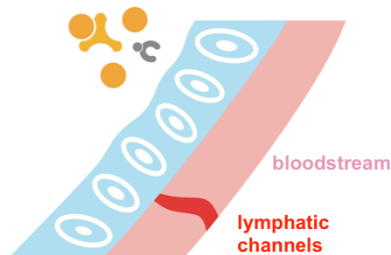


- Fatty acids are a family of molecules classified as lipid macronutrients. One of their roles within human and animal metabolism is energy production in the form of **Adenosine Triphosphate (ATP)** synthesis.
- Depending on the fat source, it can be saturated or unsaturated.

Digestion of fats

- Body uses pancreatic **lipase** and **bile** to break down fat molecules into fatty acids and monoglycerides in order to absorb them
- This process is called **hydrolysis** of fats and happens in our duodenum

ENZYME
(lipase)

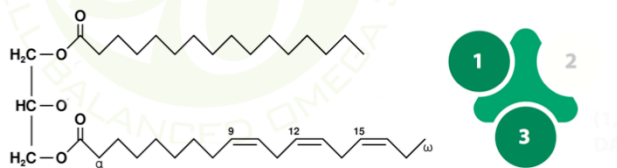


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Changes of fats during germination

- During the germination a **partial hydrolysis** of fat occurs – one or two fatty acids are released from the glycerin molecule creating **two types** of di-glycerides (**DAGs**) or mono-glycerides (**MAGs**)
- The freed fatty acids are immediately used-up as energy needed for seed growth
- Up to **25%** of fat in germinating hemp seed can be converted into **DAGs**



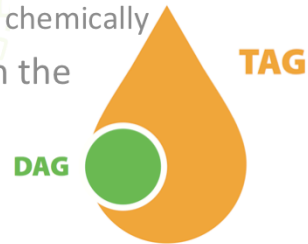
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Enzymes in germinating seed act similarly as our body fluids...

TAG / DAG difference

- Conventional cooking oils are mostly triglyceride (**TAG**) fats, with a small amount of diglyceride (**DAG**) fats
 - ✓ TAGs are hydrophobic
 - ✓ DAGs are hydrophilic – they bond water chemically
- This difference is very important from the perspective of:
 - ✓ Fat transfer in the body
 - ✓ Industrial applications



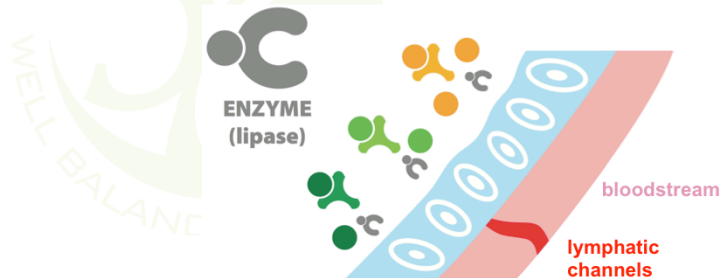
TAG / DAG difference

- 70% of the **DAG** fats in sprouted oil are in the **(1,3)** form
- The shape of the fat molecules in **germinated hemp** oil is treated differently in the digestive system



TAG / DAG difference

1. Both **TAG** and **DAG** fats are broken down the **same way**, i.e. completely hydrolyzed by lipase enzyme and bile in duodenum

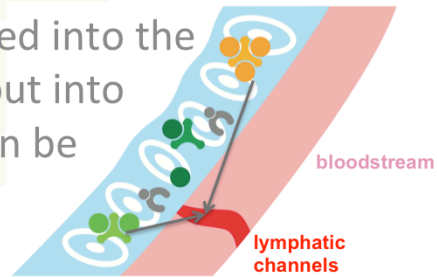


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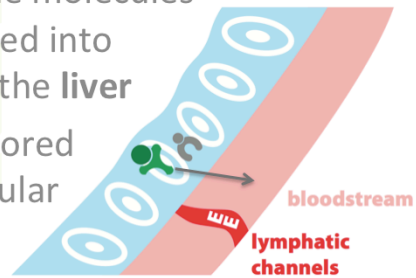
TAG / DAG difference

2. The small intestine **rebuilds** the **TAG** fats and **(1,2)DAG** fats and binds them back into **fat packets**
3. The fat packets are passed into the lymphatic system then out into the body, where they can be stored as a body fat



TAG / DAG difference

- But, due to the shape of the **(1,3)DAG** molecules in germinated oil, the intestines can not easily rebuild these molecules back into fat
- Since they are **hydrophilic**, the molecules of the **(1,3)DAG** fats are filtered into the blood and transferred to the **liver**
- **Less germinated** oil is then stored as **body fat**, compared to regular vegetable oils



Role of liver - DHA conversion

- Liver is the major site of ALA to DHA conversion
- Human brain needs 4,6 mg of DHA per day
- In case of adequate ALA supply, the conversion rate is 8-10 times bigger that of the brain:
“Based upon kinetic evidence, dietary studies with ALA, and human studies, the conversion of ALA to DHA by the liver ... will provide ample DHA when sufficient ALA (>1200 mg) is consumed.”*
- This corresponds to ca 10ml of hemp seed oil per day

*Gwendolyn Barceló-Coblijn, Eric J. Murphy, Alpha-linolenic acid and its conversion to longer chain n-3 fatty acids: Benefits for human health and a role in maintaining tissue n-3 fatty acid levels

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Docosahexaenoic acid (DHA) is fatty acid that is a primary structural component of the human brain

Alpha linoleic acid is one of two essential fatty acids

Both of them are omega 3 FAs

Role of liver - ATP synthesis

- ATP is often called the "molecular unit of currency" of intracellular **energy transfer**
- ATP transports **chemical energy** within cells for metabolism
- Can you imagine a sports performance gel based on emulsion made from DAG hemp oil?

PART III.

Preliminary results

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Our background

- We are working closely with Dr. Ferenc Föglein on industrial-scale germination of hemp seed and it's further processing
- We use 100% Canadian Certified Organic hemp seed Finola variety for our trials. Seed is being provided by Hemp Oil Canada Inc.
- Two production runs have been done:
 - ✓ 400 kgs of seed processed
 - ✓ 24 hours average germination period
 - ✓ wet seeds dried down to 7% MC
 - ✓ cold-pressed oil
 - ✓ milled presscake / 33% protein powder
- Further trials are ahead of us in order to fine-tune the germination timing and quality of finished products

Changes in germinating hemp seed – other nutrients

Below analysis in milled press cake:

- **Carbohydrates**

- ✓ sugars content decreases
 - 2 g/100g -> 0,1 g/100g

- **Proteins**

- ✓ broken into oligopeptides or individual amino acids. It is also rich in active enzymes that assist quality digesting
- ✓ total protein content remains unchanged
 - -> 33 g/100g

The germinating seed needs energy for its growth. In the first hours of germination the sugars get consumed and longer-chain carbohydrates get converted into simple sugars.

Also, protein bundles get broken down into oligopeptides or even amino acids. Active enzymes further assist quality digesting so biological value maximizes while keeping the total protein content unchanged.

Changes in germinating hemp seed – fats

Fatty Acid profile in hemp seed oil [%]

Fatty acid	Regular Canadian HSO	HSO from germinated Canadian hempseed
Oleic ω -9	10.32	9.54
Linoleic ω -6	55.77	55.27
Gamma Linolenic ω -6	3.98	4.37
Alpha Linolenic ω -3	18.33	17.95
Stearidonic ω -3	1.18	N/A
Free Fatty Acids	0.59	0.99

DAG+MAG total	Hydrolyzed lipid %				
	control seed	after 6 hours	after 12 hours	after 18 hours	after 24 hours
	0.5	5	8.2	17.5	24.3

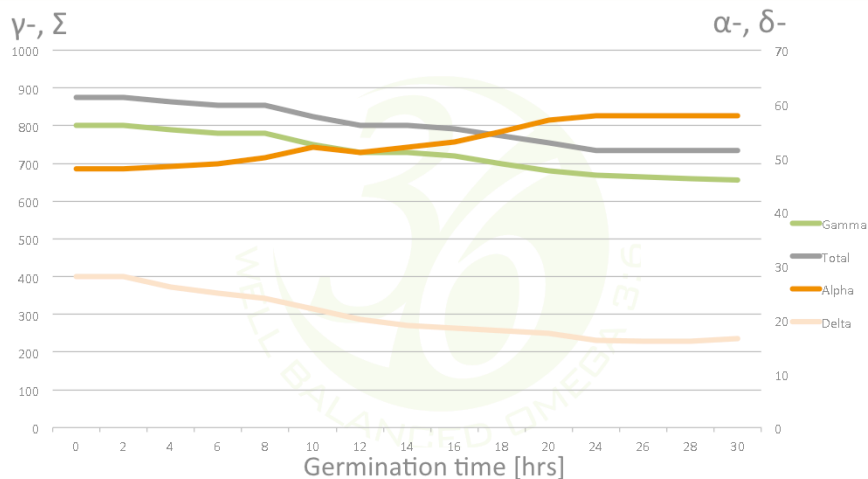
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The table provided demonstrates the changes of fat composition in sprouted hempseed oil compared to regular Canadian HSO. As we can see the ratio of fatty does not change significantly. Also content of FFAs has not shifted too much because as we said, all freed FAs are used for energy needed for hemp seed growth, even though it has just woken up.

Partial hydrolysis of fats progresses quite rapidly within 24 hrs. Conversion of fat is controlled by seed genetics and eventually stops. What happens next is the seed starts consuming it's own fat and overall oil content goes down. This is certainly not what we want for further oil production. So knowing when to stop the germination by efficient drying is crucial in germinating oily seeds in general.

Changes in germinating hemp seed - Tocopherols [mg/kg of fat]



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Tocopherols have many biological functions, the antioxidant function being the most important one. Other functions include enzymatic activities, gene expression, and neurological functions. While alpha tocopherol inhibits the production of new free radicals, gamma tocopherol is required to trap and neutralize existing free radicals. Alpha tocopherol, also known as vitamin E, is the most biologically active form. It protects cell membranes from oxidation. We can demonstrate 20% positive shift in it's value over 30 hour period. Gamma Tocopherol's key benefit is to dramatically reduce inflammatory threats. We can clearly see the shift between gamma and alpha forms.

Future challenges

- With certain technology we can increase **DAG** content up to **70-75%**
- This process requires **homogenization** when cell structure gets broken down and the **seed genetics** does not **control** the fat hydrolysis anymore
- When blended with water this leads to a **stable emulsion** with **chemically** bonded water molecules
- Now again, can you imagine a sports performance gel based on emulsion made from **DAG hemp oil**?



Thank you for your attention.

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