THE ROLE OF FAT İN MARİNE FİSH HEALTH AND PERFORMANCE: THE İMPORTANCE OF A HİGH HYDROPHİLİC–LİPOPHİLİC BALANCE (HLB) FOR SECTOR RESİLİENCE

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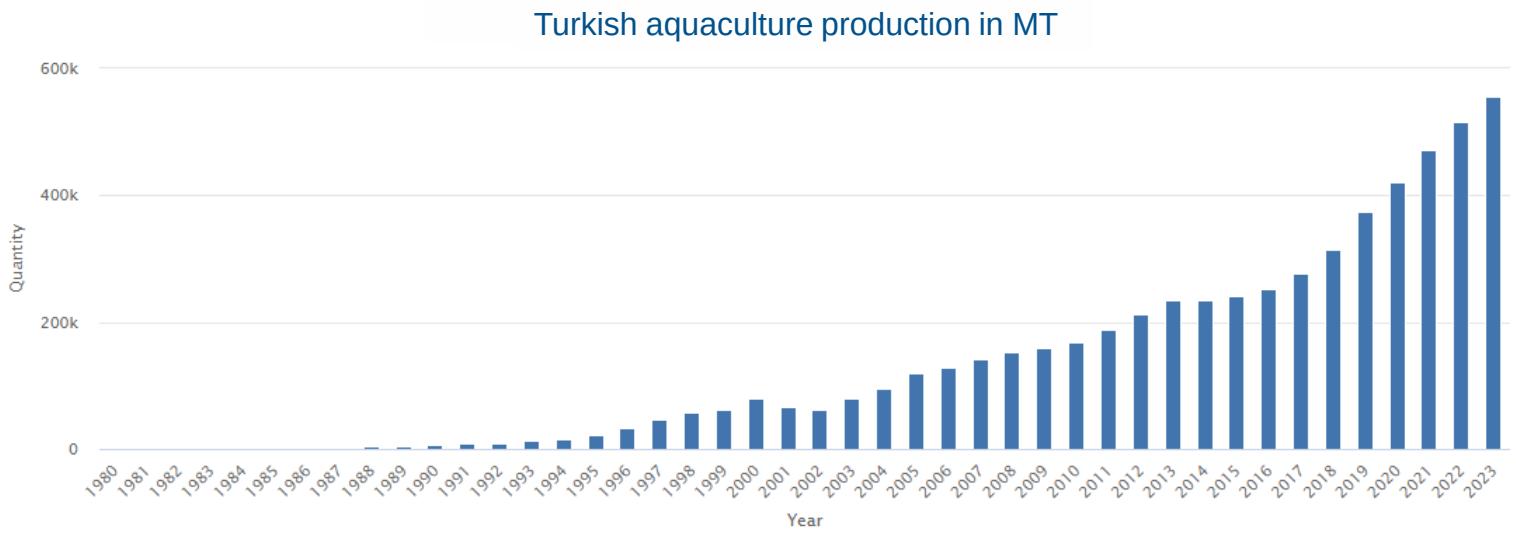
AQUACULTURE İS A GROWİNG BUSİNESS

The graph below shows total aquaculture production in Turkey according to FAO statistics:

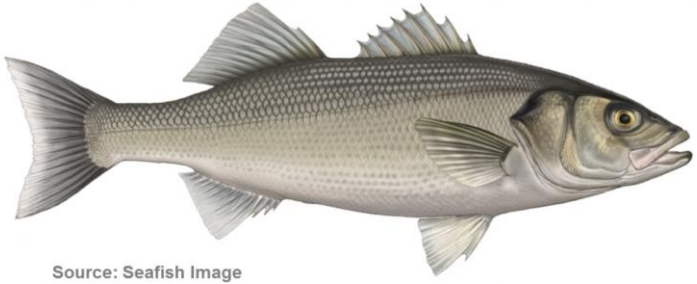
Chart | Table



HE ART OF GROWING

AQUACULTURE İS A GROWİNG BUSİNESS

Main species



Source: Seafish Image

AQUACULTURE İS ALSO SERİOUSLY CHALLENGED

- High feed prices
- Low margins
- Temperature extremes (high & low)
- Disease pressure

→ All big threats to our sector

THE ROLE OF FAT DİGESTİON İN THE AQUACULTURE SECTOR

Fat digestion is critically important in all major marine and salmonid species

- Essential for growth performance and animal maintenance
- Supports immune functioning
- Reduces thermal stress
- Increases fish resilience

THE ROLE OF FAT DİGESTİON İN THE AQUACULTURE SECTOR

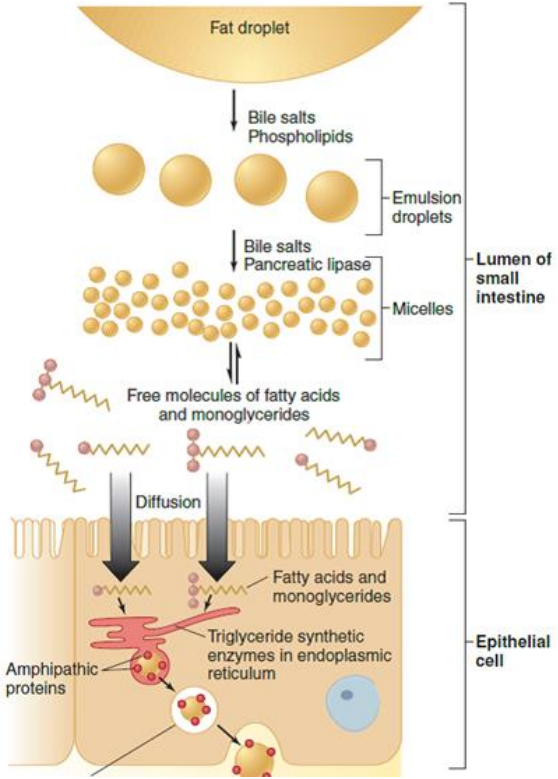
But fat digestion is at the same time a very difficult topic in marine fish

- Oil levels are very high in aquaculture diets
- There is pressure to reduce fish oil
- Limited endogenous emulsifiers
- Diseases & temperature stress further lower fat digestion

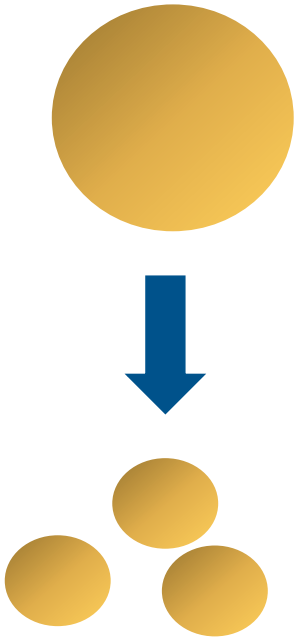
Without good emulsification, lipase cannot access triglycerides → fat remains undigested → energy wasted.

FAT DİGESTİON – THE ROLE OF EMULSİFİCATİON

***Emulsification**:*
During emulsification, big fat globules need to be transformed in small droplets that are equally dispersed in the watery environment, called an emulsion.
When one big fat globule is divided in multiple small fat droplets, this results in an increase of surface area.



FAT DİGESTİON – THE ROLE OF EMULSİFİCATİON



Number of Droplets	Volume per Droplet	Radius (r)	Surface per Droplet	Total Surface Area	Total Volume
1	1000	6.22	486.95	**486.95**	1000
2	500	4.93	305.36	**610.72**	1000
3	333.33	4.26	228.02	**684.06**	1000
4	250	3.91	192.43	**769.72**	1000
5	200	3.68	170.40	**852.00**	1000
10	100	2.88	104.29	**1042.9**	1000
20	50	2.29	65.84	**1316.8**	1000

≠ =

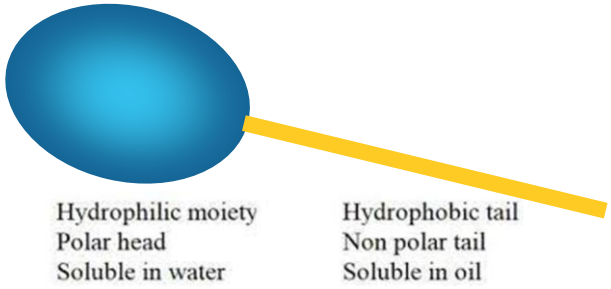
Bile salts are the animal's natural emulsifiers

Emulsifiers decrease the interfacial tension at the oil/water interface and stabilize droplets

More surface = more emulsifier needed to stabilize

EMULSİFİERS
HLB value – What is HLB?

- Emulsifiers exist of a Polar Hydrophilic Head (Soluble in Water), and a Non-polar Lipophilic Tail (Soluble in Fat)
- **HLB = Hydrophilic – Lipophilic Balance**
- A range **from 0 to 20** *(according to Griffin's scale)*
  - Low HLB value = small head and larger tail
  - High HLB value = larger head and smaller tail

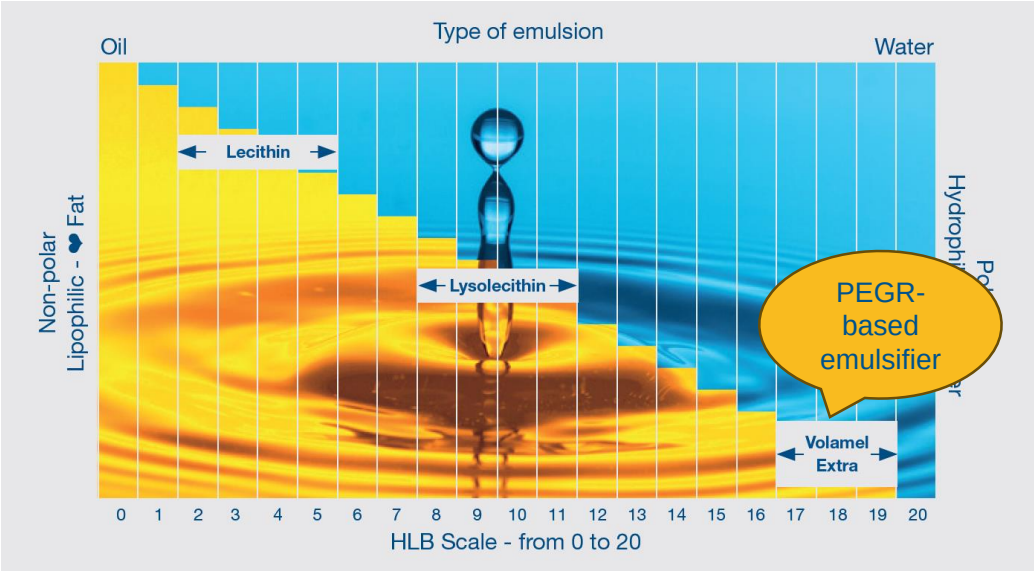


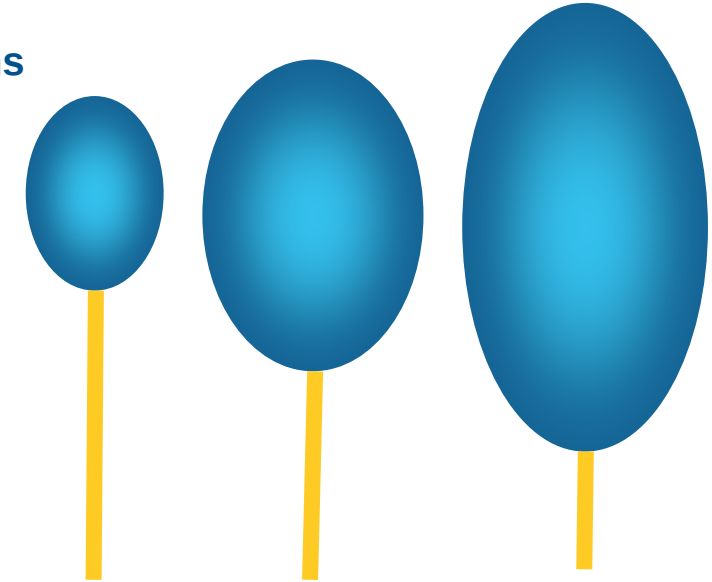
Different HLB emulsifiers are used for different practices

EMULSİFİERS

Different HLB value for different practices

Water in oil (W-O) emulsions or **Oil in water (O-W) emulsions**

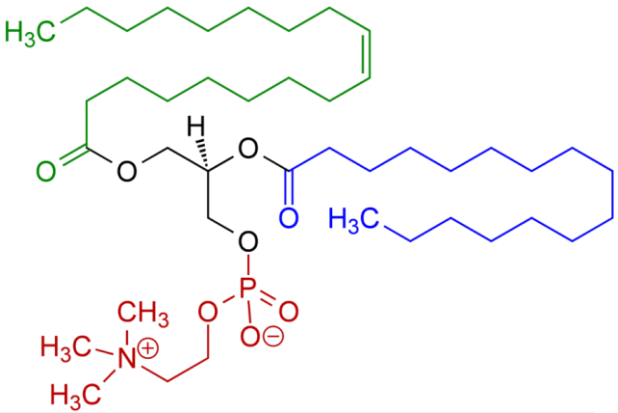




- Low HLB = small head and larger tail
- High HLB = larger head and smaller tail

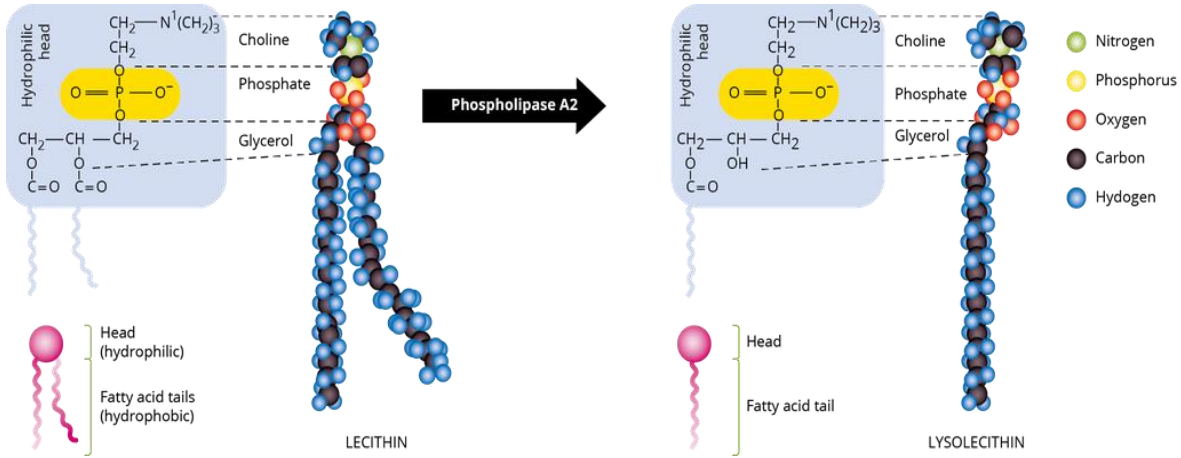
EMULSİFİERS
Low HLB value (1-5)

- Example: **Lecithin**
  (phospholipids derived from vegetable sources such as soybeans)
- Commonly used as an emulsifier in animal feed to improve the dispersion of fat-soluble vitamins
- For **stability and quality of the feed**
- **No/little effect on the digestibility** of fats and oils



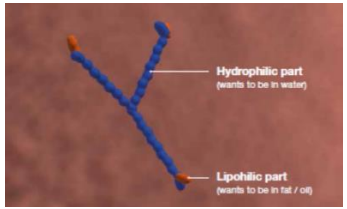
EMULSİFİERS
Medium HLB value (5-12)

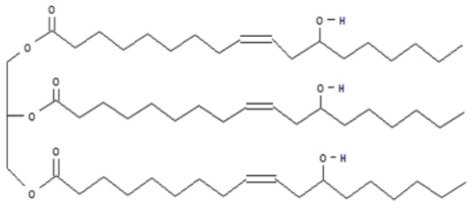
- Example: **Lysolecithin** = Lysophospolipids
  (by hydrolysis of lecithin and removal of one lipophilic tail)
- Earlier generation of emulsifiers (O-W emulsion)
- Small positive effect on fat digestibility, yet limited due to suboptimal HLB for intestinal environment



EMULSİFİERS
High HLB value (12-18)

- Example: **Glyceryl polyethylene glycol ricinoleate (PEGR / GPGR / E484)** (Castor oil ethoxylate)
- Newest generation of emulsifiers to improve oil-in-water emulsion (O-W emulsion)
- **Higher HLB value ensures optimal fat digestibility**
- HLB value close to 18 (as in **Volamel Extra**) is ideal for the emulsification process in the intestinal environment





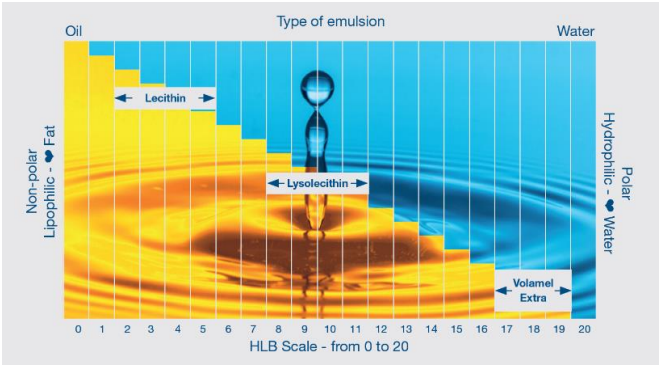
EMULSİFİERS
Very high HLB value (19-20)

- Example: **detergents or surfactants**
  (Cleaning products, medicine and industrial applications)
- Emulsifiers with extreme oil-in-water emulsion
- **HLB value too high to improve fat digestibility**
- Not wise to use in animal feed production
  Cleaning detergents to clean extremely well

HLB VALUE OF 18 İS OPTİMAL

For animal nutrition

- Intestine is a very watery environment
- In this watery environment there is at least twice as much water as feed
- Limited amounts of oil/fat in the entire intestine
- Emulsifiers with an HLB of around 18 seems to mimic the environment of the gut as close as possible
- And is therefore best to support the bile salts, animals' natural emulsifiers



THE ROLE OF FAT DİGESTİON İN THE AQUACULTURE SECTOR

How a high HLB emulsifier can be of vital importance for the aquaculture sector:

- Efficient fat digestion = direct feed cost savings
- Fat digestion is one of the most temperature-sensitive processes in fish. Adding a high HLB emulsifier can decrease the negative effects of heat stress
- Better digestion = higher resilience to infections and diseases

EFFİCİENT FAT DİGESTİON = DİRECT FEED COST SAVİNGS

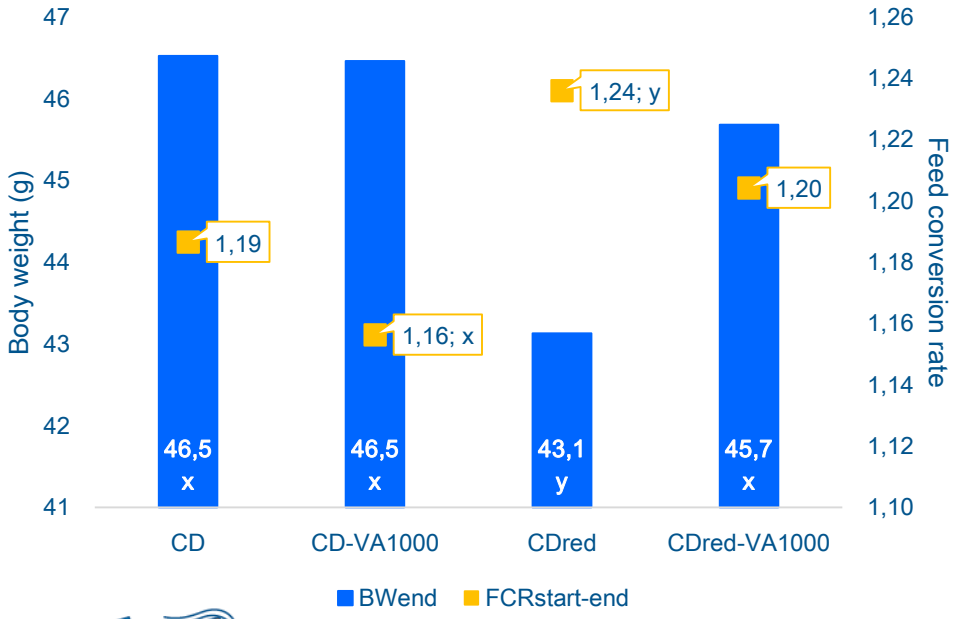
European seabass (*Dicentrarchus labrax)* trial:

- HCMR Greece
- Juvenile stage (18 g)

- Control Diet (CD) (16% fat, 8% fish oil)
- Control Diet + 1000 ppm VA (on top) (CD-VA1000) (16% fat, 8% fish oil)
- Fish oil (FO)-reduced diet (-2% FO; -130 kcal/kg of feed) (CDred) (14% fat, 6% fish oil)
- FO-reduced diet + 1000 ppm VA (CDred-VA1000) (14% fat, 6% fish oil)

- 130 kcal/kg feed

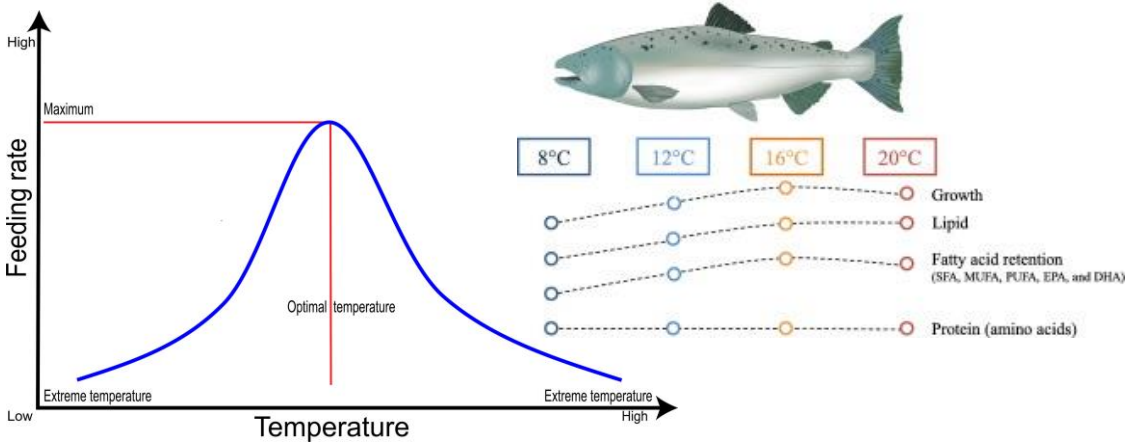
EFFİCİENT FAT DİGESTİON = DİRECT FEED COST SAVİNGS

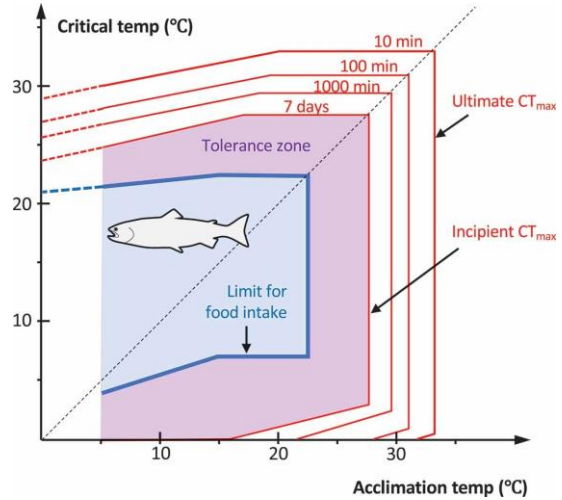


By using a high HLB emulsifier, 2% of FO can be reduced

NUTRİENT DIGESTION AND METABOLİSM

With increasing temperatures, the effect of warm water on nutrient digestibility is also clear.





Thermal tolerance polygon for Atlantic salmon. Volkhoff et al. (2020)

HİGH HLB EMULSİFİERS AGAİNST HEAT STRESS

Gilthead seabream (*Sparus aurata)* trial

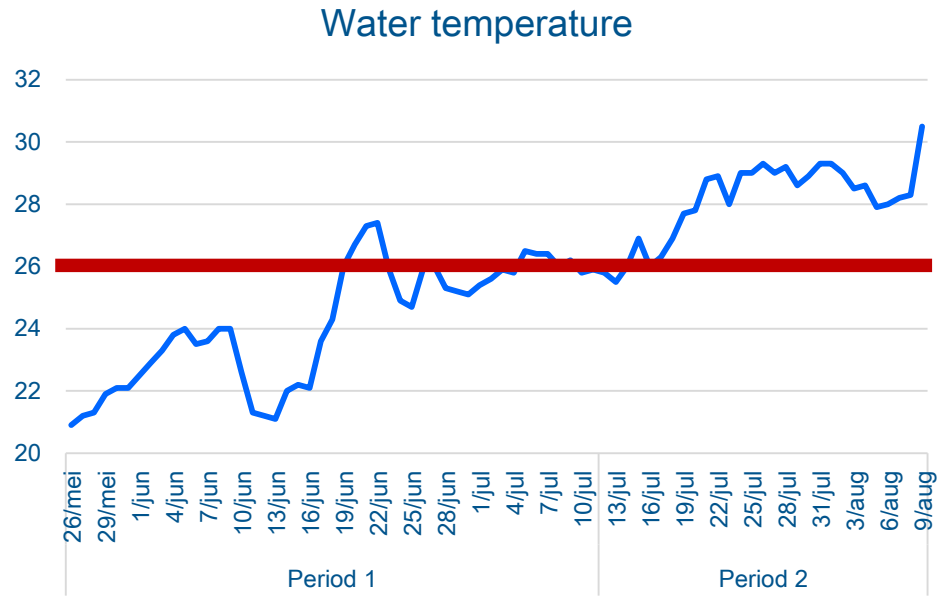
- The effect of heat stress on the fish and the mitigating effects of Volamel Extra (high HLB emulsifier)
- IATS Spain; juvenile fish (15-30 g)

- Control Diet (HFD) (16% fat, 8% fish oil)
- Control Diet + 1000 ppm VA (on top) (HFD-EMS) (16% fat, 8% fish oil)
- Fish oil (FO)-reduced diet (-2% FO; -130 kcal/kg of feed) (LFD) (14% fat, 6% fish oil)
- FO-reduced diet + 1000 ppm VA (LFD-EMS) (14% fat, 6% fish oil)

- 130 kcal/kg feed

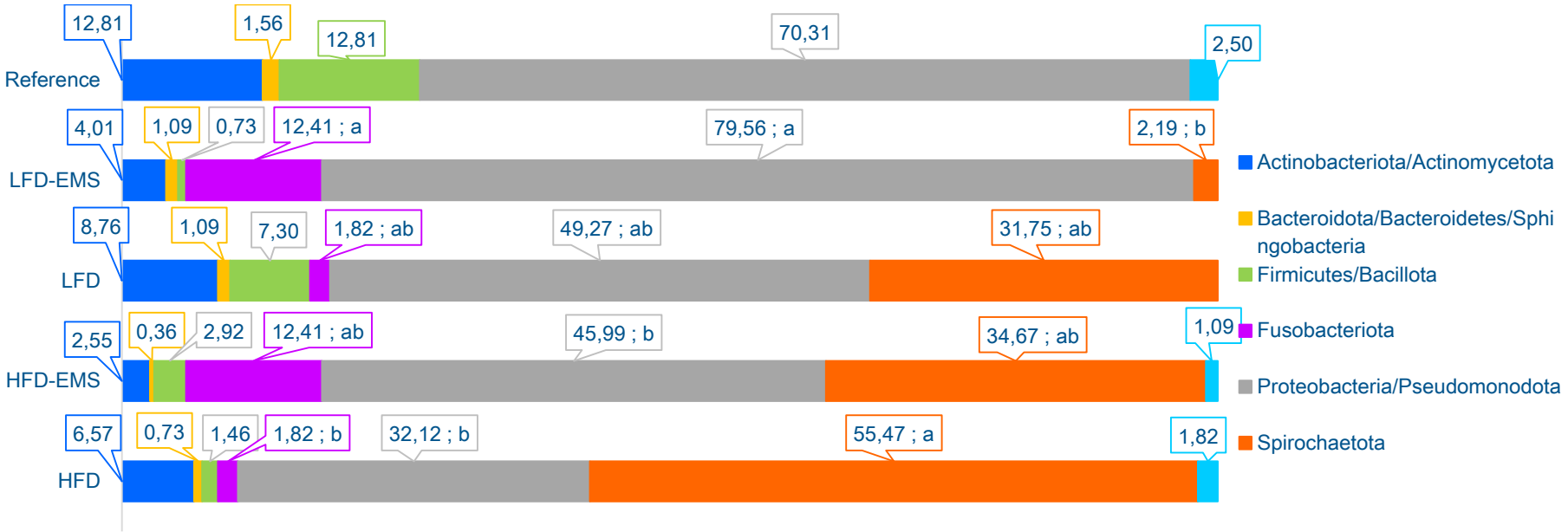
GİLTHEAD SEABREAM

Water temperature



GİLTHEAD SEABREAM

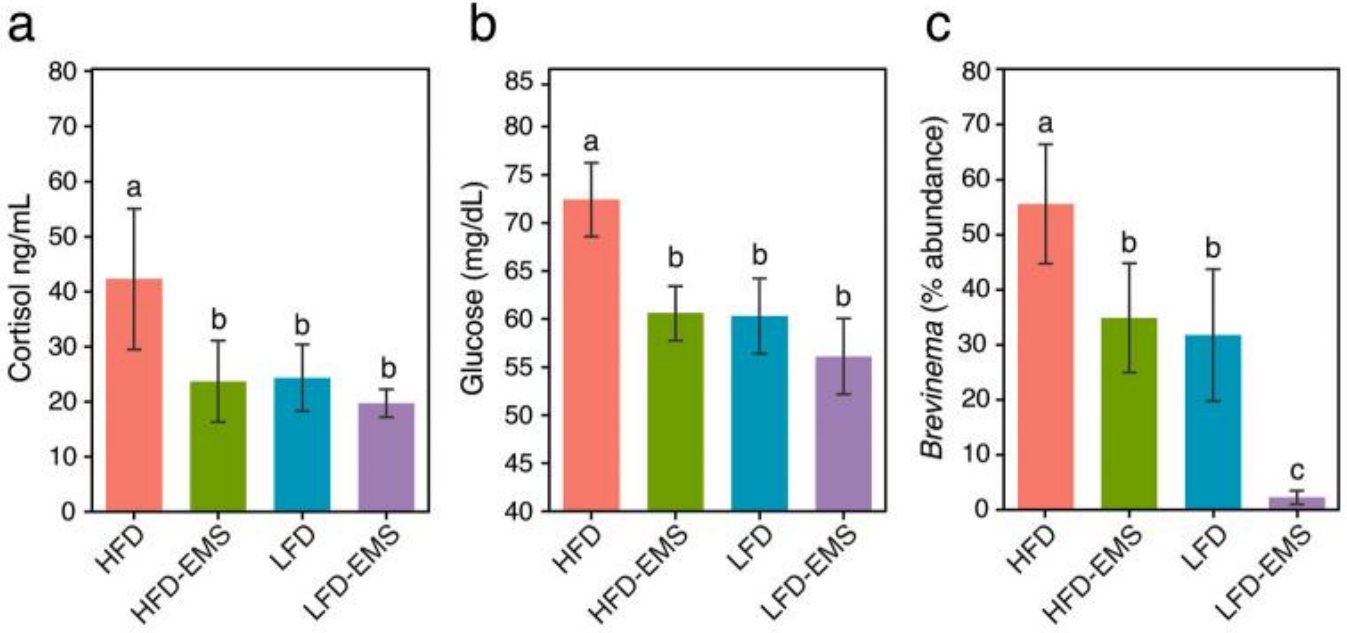
Phylum relative abundances (P)



GİLTHEAD SEABREAM

Nukamel

Stress levels in the fish lowered by addition of Volamel Extra Aqua



TURKİSH SALMON (*ONCORHYNCHUS MYKİSS*)

Study looking at the capacity of different dietary inclusion levels of a high HLB emulsifier (Volamel Extra Aqua) during heat stress

- **Trial set up (27/08/2024 – 20/11/2024):**
  - 12 indoor tanks (RAS; 500 L): 4 T x 3 R
  - Week 1 to 8: water temperature: 16 (±2)°C
  - Week 9 to 12: water temperature: 22 (±2)°C
- Fish:
  - BW_{start} = 112 g (50 fish/tank, randomly)
  - Live BW: every two weeks
  - Carcass: HSI, VSI, K [day 0 (30 fish), week 8 and 12 (10 fish/T)]

TURKİSH SALMON

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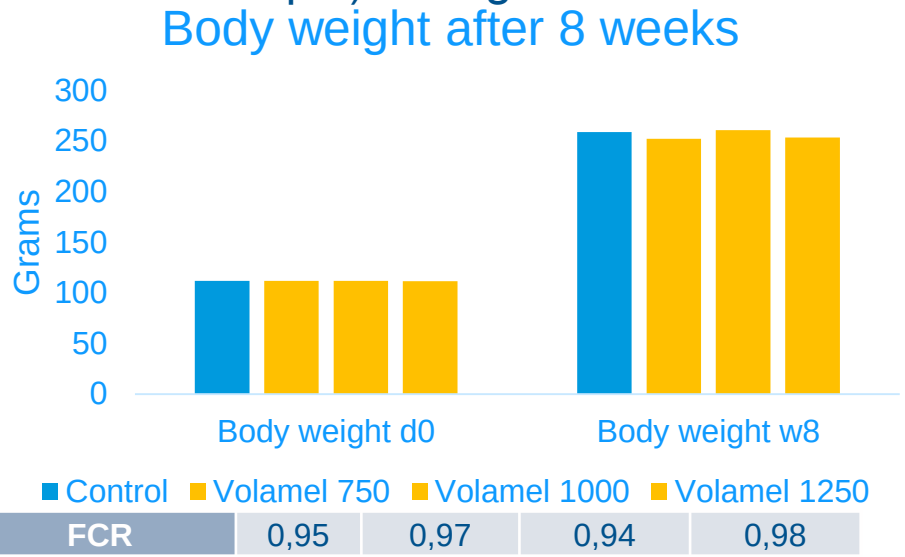


	Control	Volamel 750	Volamel 1000	Volamel 1250
FCR	0,95	0,97	0,94	0,98

In the first 8 weeks the growth and feed efficiency was good!

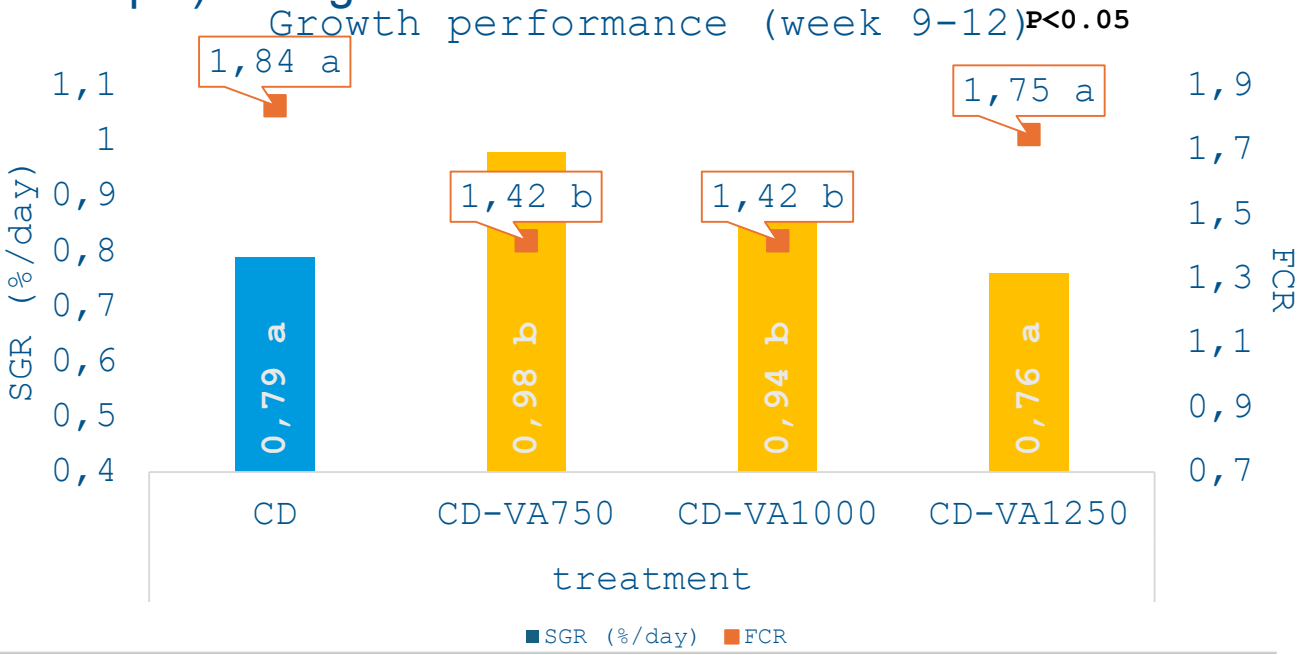
No differences observed amongst treatments

TURKİSH SALMON

Study looking at the capacity of different dietary inclusion levels of a high HLB emulsifier (Volamel Extra Aqua) during heat stress

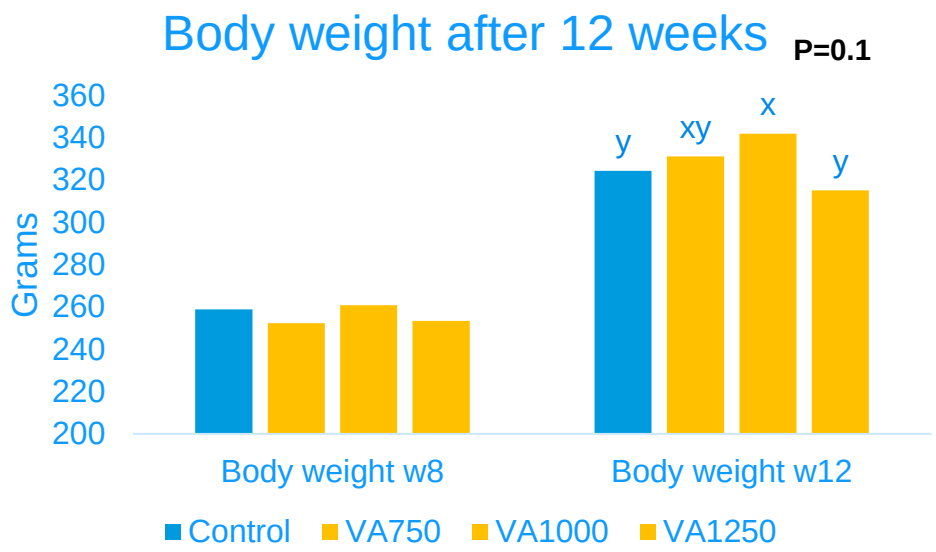
During heat stress SGR drops and FCR increases.
A high HLB emulsifier improved the performance, countering bad effects of the stress

Strategy against heat stress!!!



TURKİSH SALMON

Study looking at the capacity of different dietary inclusion levels of a nutritional emulsifier **(Volamel Extra Aqua)** to improve heat stress tolerance.



After 12 weeks a clear improvement is seen in the emulsifier groups with 750 and 1000 g/MT inclusion compared to control

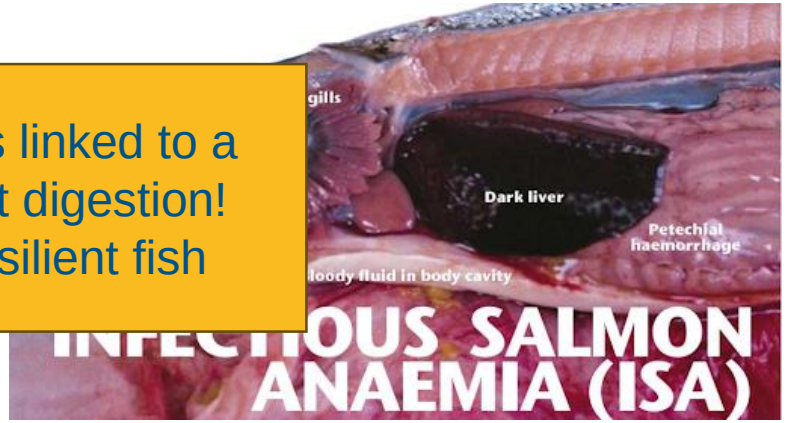
1 kg/MT best growth performance

HİGH HLB EMULSİFİERS AGAİNST DİSEASE PRESSURE

Nukamel

In Chile, a high HLB emulsifier, Volamel Extra Aqua, is an important part of the strategy against ISA-virus in Coho Salmon and Atlantic Salmon

Better health is linked to a stable, high fat digestion!
Leading to resilient fish



The health package, with this high HLB emulsifier as most important part, can reduce the effect on fish (decreased mortality and growth loss).
Additionally, it is also shown to reduce the appearance of anaemia in the fish fillet

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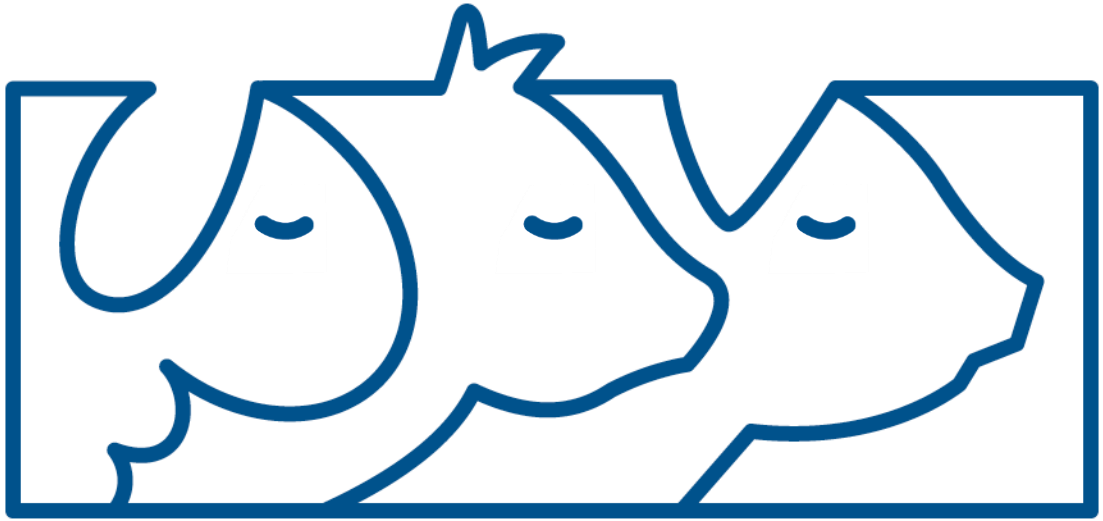

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