Fat-binding affinity of LipoSan Ultra®
a chitosan fibre to promote health

Hélène L. Lauzon, Gudný H. Kristjánsdóttir, Vala Árnadóttir

Dietary fibres are known to contribute to digestive health. Chitosan, a dietary supplement and natural fibre extracted from crustacean shell, has been used to prevent dietary fat absorption. Recently, a study demonstrated that ChitoClear® chitosan selectively reduced fat absorption and had a greater binding affinity to fatty acids with higher polarities. This was based on the recovery of fatty acids in the faeces of guinea pigs fed a fibre-rich diet.[1] As the composition of dietary fat can influence our lipid metabolism, it is important to consider how chitosan will perform in binding different types of fats included in our diet. A study was initiated to evaluate the fat-binding capacity of LipoSan Ultra®, prepared from ChitoClear® chitosan, towards commonly consumed lipids: butter and oil of olive, rapeseed, corn, soybean, sunflower, peanut and coconut. LipoSan Ultra® had a greater fat-binding capacity at 37°C than 22°C, while its binding affinity varied among the different fat and oils tested.

Material & Method

An *in vitro* fat-binding test was performed at room temperature and 37°C in 0.16N HCL mimicking stomach acid, with 0.06g of LipoSan Ultra® chitosan and 10g of fat, allowing the determination of fat-binding capacity of up to 167g of fat per g LipoSan Ultra®. The solubilisation time was set to 5 min for a standardized test. The mixture was then neutralized with a carbonate buffer, precipitating chitosan to entrap the fat into a semi-solid emulsion. Free fat was separated from bound fat by centrifugation, and bound fat indirectly quantified to calculate the fat-binding capacity as grams of fat bound per gram of material tested. Duplicate samples were analysed and reported as mean values (± SD).

The fat and oils selected were the following: butter and oil of coconut, olive, corn, rapeseed, peanut, sunflower, soybean and grapeseed. Their fatty acid profile is presented below, to show the main differences among the lipids tested.

FATTY ACID	butyric-caproic	caprylic	capric	lauric	myristic	palmitic	margaric	stearic	arachidic-behenic-lignoceric	Total
OIL TYPE[2]	C4:0-C6:0	C8:0	C10:0	C12:0	C14:0	C16:0	C17:0	C18:0	C20:0-C24:0	SFA
Coconut oil		6,38	5,56	**45,46**	**18,8**	10,1		4,3	0,1	90,7
Olive oil						8,7	0,2	3,5	0,6	13,0
Butter**	5,2	1,2	2,5	**2,6**	**7,4**	**21,7**		10		50,6
Corn oil						10,3	0,1	2	1,0	13,4
Grapeseed oil*						7		4		11,0
Soybean oil					0,06	9,9	0,1	3,94	1,1	15,1
Rapeseed oil					0,1	3,7		1,9	1,26	7,0
Peanut oil						9,4	0,1	2,7	6,2	18,4
Sunflower oil					0,1	5,7		4,8	1,3	11,9

FATTY ACID	palmitoleic	myristoleic	oleic	gadoleic	erucic-nervonic	Total	linoleic	linolenic	eicosadienoic	docosodienoic	Total
OIL TYPE[2]	C16:1ω7	C17:1ω5	C18:1ω9	C20:1ω9	C22:1-C24:1ω9	MUFA	C18:2ω6	C18:3ω3	C20:2ω6	C22:2ω6	PUFA
Coconut oil			7,45	0,06		7,5	1,8				1,8
Olive oil	0,5	0,3	76,3	0,3		77,4	8,6	0,8		0,2	9,6
Butter**	1		**20**			21,0	2,7	0,3			3,0
Corn oil			**25,5**	0,4	0,2	26,1	**59,3**	1,1	0,1		60,5
Grapeseed oil*	0,3		**15,8**			16,1	**69,6**	0,1			70,0
Soybean oil	0,08	0,08	**21,35**	0,22		21,7	**56,02**	7,15			63,2
Rapeseed oil	0,2		**62,4**	1,5	0,3	64,4	**20,1**	8,4	0,1		28,6
Peanut oil	0,1		**48,7**	1,4	0,1	50,3	**31,1**	0,2			31,3
Sunflower oil	0,1		**16,8**	0,2		17,1	**70,7**	0,3			71,0

*https://en.wikipedia.org/wiki/Grape_seed_oil
**USDA average: http://www.eatwisconsincheese.com/dairy/butter/butter-basics/composition-of-butter

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Corresponding author: helene@primex.is

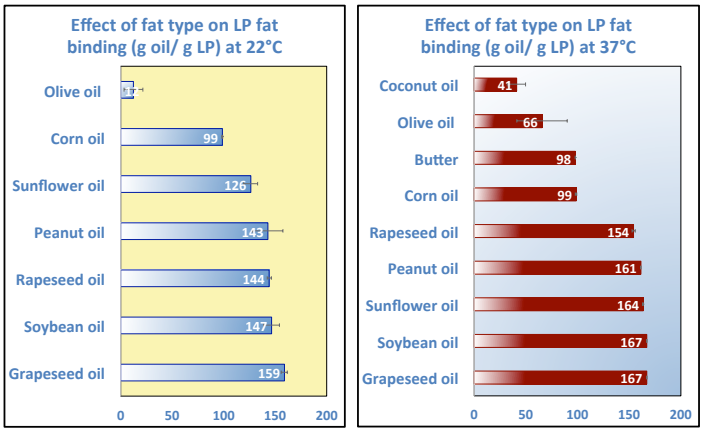

Figure 1. Fat-binding capacity of LipoSan Ultra® at 22 and 37°C

Results

Figure 1 demonstrates that LipoSan Ultra® had a greater fat-binding capacity at body temperature than 22°C. In general it bound about 100 times or more of fat compared to its weight when dissolved in simulated stomach acid. A greater binding affinity was observed for lipids rich in linoleic acid (omega-6) or compensated with high levels of oleic acid (omega-9), representing together about 80-85% of fatty acid profile. A lesser affinity was seen for coconut and olive oil, which were both low (<10%) in linoleic acid but high in oleic acid (>75% for olive oil) or medium-chain fatty acids (MCFAs, >55% for coconut oil). This is noteworthy, considering their health promoting effects.

Significance of the study

LipoSan Ultra® chitosan is a safe and effective dietary supplement for weight management and cholesterol control. It rapidly dissolves in stomach acid, complexes and traps fats and oils, thereby reducing the digestion of dietary fat and limiting the calorie intake. The study demonstrated the high efficacy of LipoSan Ultra® in binding dietary fats, but also its varying affinity.

The selective fat-binding of LipoSan Ultra® reported here may contribute to a healthier lipid array being absorbed by our body. Oleic acid is known to decrease LDL-cholesterol but does not affect HDL-cholesterol levels.[2] MCFAs are absorbed directly into the liver and used as an energy source; they can suppress fat deposition through enhanced thermogenesis and fat oxidation; and may offer the therapeutic advantage of preserving insulin sensitivity in animal models and patients with type 2 diabetes.[3]

Polyunsaturated fatty acids (PUFAs) are of major importance in normal physiological functions. Despite the fact that some PUFAs are not produced in our body and therefore considered to be essential, excessive amounts of omega-6 PUFAs and very high ω6/ω3 ratios in our diet may promote the pathogenesis of many diseases associated with pro-inflammatory and prothrombic mediators.[4] Therefore, the reduction of this ratio is important to approach more desirable levels. **LipoSan Ultra® can contribute to equilibrate our diet selectively providing health promoting fatty acids.**