Pectin reduces blood cholesterol level

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Introduction

Pectin is a complex polysaccharide present in plant cell walls, commonly presents in fruits and vegetables, commercially extracted from pulp waster during fruits juice processing. Pectin can be used as gelling agent in jams, marmalades and reduced sugar versions. It creates thickened textures and a homogenous distribution of fruit pieces. The consumption of pectin by human influences transit rate, nutrient absorption rate, and cholesterol absorption and secretion, so pectin is an important dietary fiber. However, the clinical use of pectin is very rarely mentioned (F Brouns, 2012).

The degree of esterification (DE) demonstrates the methyl esters in pectin chains. The pectin with DE> 50% are high-methoxyl and forms viscous gels in the stomach at pH 2. 2-3. 5 (Ralet et al., 1994; Sila et al., 2009); the pectin with DE <50% are low-methoxyl. The high-methoxyl pectin form gels with high sugar content (> 60%) at low pH; low-methoxyl pectin forms gels with divalent cations (notably Ca^{2+}) at pH 2. 5-6 (sugar addition not required) (Thibault and Ralet, 2008).

Cholesterol is an important biological molecule, which function as component of cell membrane structure as well as a precursor for the synthesis of the steroid hormones and bile acids. High concentration of cholesterol in human blood is related with coronary vascular disease, atherosis, stroke and many other diseases.

European Food Safety Authority (EFSA) (ESFA, 2010) has published the cholesterol lowing effects of of pectin on glycemia. In general, processing

factors like DE, MW, and pectin source (e. g. citrus or apple) may affect the efficacy of pectin (Baker, 1997; Duvetter et al., 2009).

Cholesterol lowering in animals

Pectin has been reported being able to lower the cholesterol level of blood and liver in various animals, including guinea pigs (Gorinstein et al., 2005), rats (Krzysik et al., 2011), hamsters (Terpstra et al., 2002), chickens (Craig et al., 2006) and rabbits (Ismail et al., 1999). The effect of lowing cholesterol level by nine types of pectin with different molecular composition on 486 male broilers was studies, their serum cholesterol lowing efficacy was ranked as: citrus pectin DE-70 1⁄4 apple pectin DE-74apple pectin DE-354citrus pectin DE-04low-MW pectin4citrus pectin DE-354cellulose (Craig et al., 2006).

The mechanisms of cholesterol lowering in animals mostly are increasing fecal bile acid excretion, reduced plasma triacylglycerol, plasma total cholesterol, hepatic triacylglycerol, cholesterol synthesis and absorption, *et al* . Some of the mechanisms may be related with humans (F Brouns, 2012). The result of experiments feeding Wistar rats with semipurified diet with psyllium or pectin, cellulose or rice bran supported the hypothesis that the hypocholesterolemic effect of soluble fibers is functioning by increasing synthesis and therefore pool size of bile acids (Hugh B. Matheson, 1995). Another study showed that the hydrophobic amidated pectins significantly modify cholesterol homeostasis in rants and might provide insight of an effective hypochelosterolemic agent. However, the amidation of pectin might

reduce its fermentability (M. MAROUNEK, 2007). Overall, pectin influence animal blood cholesterol by affecting cholesterol homeostasis.

Cholesterol lowering in humans

There are not many clinical studies of pectin cholesterol lowing compared with animal studies. Generally, each gram of pectin lowers LDL cholesterol (LDL-C) by 0. 055mmol/L (Brown et al., 1999). A cause-and-effect relationship has been established with 6g pectin in ≥ 1 servings for maintenance of normal blood cholesterol concentration (ESFA, 2010).

The table 1 summarized the most important studies of pectin lowering cholesterol level before 1988 (Kay Behall, 1986) (Cerda, 1988)

Table 1. Pectin Lowering Cholesterol Level Studies Before 1988

Reference	Subjects	Time Week	Diet	Amount Pectin g/d	Cholesterol
Key et al. (1961)	24	3	Controlled	15	-5%
Fahrenbach et al. (1965)	23	7-9	?	6-12	0
Palmer et al. (1966)	16	4	Self-served	2-10	-6% for ≥6g

					pectin/d
Jenkins et al. (1975)	12	4	Self-served	36	-12%
Hopson et al. (1975)	3	5	Controlled	20-23	-13%
Durrington et al. (1976)	12	3	Self-served	12	-8%
Kay et al. (1977)	9	3	Controlled	15	-13%
Raymond et al. (1977)	6	4	Controlled	2	0
Delbarre et al. (1977)	10	6	Controlled	6	0
Langley et al. (1977)	11	4	Controlled	10	Significant decrease
Jenkins et al. (1979)	5	3	Controlled	30	-13%
Ginter et al.	21	6	Self-served	15	-9%

(1979)	11	6	Self-served	15	-19%
Stasse-Wolthuis et al. (1980)	62	5	Controlled	15	-10%
Nakamura et al. (1982)	12	2	?	9	-16% -18%
Judd et al. (1982)	10	3	Self-served	15	-16%
	10	3	Self-served	15	-18%
Challen et al. (1983)	6	3	Controlled	36	-10%
Cerda et al. (1988)	27	4	Self-served	15	-15%

A recent crossover study involves hyper-cholesterolemic persons receiving either 15g/day pectin (from citrus or apple, with different DE level) or cellulose with food for 4 weeks. The result showed that (F Brouns, 2012):

1. For relative low-density lipoprotein (LDL) cholesterol (LDL-C), the effect of citrus pectin and apple pectin are the same, while the pectin with

higher level of DE level has better hypocholesterolemic effect. Orange pump fiber worked worse than citrus and apple pectin.

2. The pectin with higher molecular weight works better than the pectin with low molecular weight.
3. In the subsequent experiment providing 6g pectin/day for three weeks, citrus DE-70 and high MW pectin DE-70 reduced LDL-C 6-7% compared with control group.

The viscous, gelatinizing citrus pectin alter bile acid enterohepatic circulation; enhance cholesterol excretion into stool (Martinez de Prado et al., 1981; Ide and Horii, 1989; Ide et al., 1990; Fernandez et al., 1994; Terpstra et al., 2002). High-viscosity pectin generally diminishes total cholesterol (TC) by 3-7% in humans. Pectin increases gut viscosity, then reduce the re-absorption of bile acids, increase synthesis of bile acids from cholesterol, thereby reduces circulating blood cholesterol (F Brouns, 2012). The high-viscosity pectin might also interfere with the formation of micelles and/or lower the diffusion rate of bile acid and cholesterol-containing micelles through the bolus, consequently reduce the uptake of cholesterol and bile acids. Many study suggested the favourable effect of pectin on lipids(B. R. Sharma, 2006).

The source and type of pectin (degree of esterification and molecular weight) affect the effect of lowing cholesterol. In the study by Brouns *et al.* , it is proven that increased DE and MW help promote the efficacy of lowering of human cholesterol level, and even a high dose of pectin with low DE and MW won’t have significant effect. The EFSA pectin cholesterol-lowering claim should require a minimum level of characterization, including DE and MW (F

Brouns, 2012). Even though pectin cannot be directly absorbed by human, it can be fermented by the microorganisms in the large intestine and result in the formation of short chain fatty acid, which could be absorbed and metabolized in the colonic mucosa, liver or peripheral tissue (Kay, 1982).

Effective doses

Experiments indicate that the dose of pectin needed for different people to achieve the lowering of serum cholesterol level is not the same (Grant H. Palmer, June 1966). The intake of 15 grams of pectin per day for three weeks resulted in a mean 13% diminishment of plasma cholesterol levels. A dose of 40 to 50 grams of pectin per day significantly reduced the cholesterol level in both normolipidemic and hyperlipidemic subjects(B. R. Sharma, 2006). In addition with the claim of consume 6g/day pectin to achieve hypochelosterolemic effect, ESFA (2010) also suggest that the consumption of pectin with meals help reduce the blood glucose after meal and the effect can be achieved with at least 10g pectin per meal ((EFSA), 2011).

The hypocholesterolemic effect of pectin combined with apple polyphenols has also been reported (EVA N. JENSEN and DRAGSTED, 2009). There might be taste concerns and potential gastrointestinal disturbance if more than 6g pectin/day was ingested (F Brouns, 2012). At least 6 grams of pectin are supposed to be consumed to achieve hypochelesterolemic effect, and this amount is correspond to 7~8 medium-sized apples (EVA N. JENSEN and DRAGSTED, 2009).

Some critique suggested that most of the cholesterol lowering effect of pectin is showed in a cholesterol rich, atherogenic diet (A. H. M. Terpstra,

2002). The effect of cholesterol lowing efficiency in regular diet remained quite questionable.

Conclusion

Viscous pectin can reduce the cholesterol level of animals and human by increasing synthesis and excretion of bile acid and reducing re-absorption of cholesterol. The hypochelosterolemic effect of pectin depends on the dose of pectin, diet composition, and source and physical and chemical property of pectin itself (including viscosity, molecular weight, and degrees of esterification). The effective daily intake of pectin is at least 6g/per according to EFSA, however a minimum level of characterization should be required to achieve the result.