Hypolipidaemic foods in China

Gu Jingfan MD

Chinese Nutrition Society, Beijing Institute of Hygiene and Environmental Medicine, Tianjin, China

With the changes in dietary pattern in China, in recent years, hyperlipidaemia has become an important problem in the pathogenesis of chronic degenerative diseases, especially the cardio-cerebro-vascular diseases. From studies on laboratory animals and people with hyperlipidaemia, a number of hypolipidaemic foods and beverages have been identified, of relevance to traditional Chinese food culture. Their absence from the diet may, in part account for the increasing prevalence of hyperlipidaemia in China.

The several *groups of foods used in China with hypolipidaemic effects* include:

- *Cereals*: oats, naked oats (*Avena stiva L. var. nuda Mordv.*), millet, buckwheat, wheat germ, maize germ.
- *Beans*: soybean, kidney bean, hyacinth bean, red bean, mung bean, broad bean, pea, Phaseolus L., soy dregs.
- *Aquatic*: prawn, Greater croaker, Crucian carp, squid, mussel, scallop, Silvery pomfret.
- *Fungi and algae*: mushroom, algin, kelp, laver (Porphyra yezoensis Veda), (Enteromorpha prolifera), (Auricularia polytricha).
- *Vegetables*: garlic, celery, onion, spring onion, chives, pepper.
- *Nuts and fruits*: peanut seed, walnut seed. Splinar pear (Rosa voxburghi Tratt), kiwifruit (Achinida chinensis planch).
- *Oil*: soybean oil, rice bran oil, tea seed oil, rubber seed oil, grape seed oil. fish oil, soybean phospholipid.
- *Others*: tea, brown sugar, Cr-enriched yeast, iodine-enriched eggs.

The present enquiry into a range of factors in food which may influence lipoprotein metabolism encouraging new ways of thinking about the pathogenesis, prevention and management of lipid disorders and their sequelae.

Key words: Traditional foods, hypolipidaemic, China, cereals, dietary fibre, beans, edible oils, fungi, algae, vegetables, fruit, tea, chromium, iodine

Introduction

In 1992, a nationwide nutrition survey was performed in China. The dietary pattern of Chinese had changed significantly compared with that in 1982[1]. Percentage of energy from cereals, beans, and tubers decreased while that from animal foods and pure energy foods increased. This change is typical for a country in economic transition when living standard rises in line with development of the national economy. Now, dietary fat provides 22% of energy intake on average, 28.4% in urban and 18.6% in rural areas, whereas in 1982, it was only 18.4% on average. In some big cities the fat: energy ratio has even reached more than 30%. In the meantime, the mortality from cardio-cerebro-vascular diseases in cities has also increased from 72.92/100,000 in 1963 to 207.76/ 100,000 in 1992[2]. As causes of total death, these diseases were 13.6% in 1962 and 35.8% in 1992[2]. As hyperlipidaemia is one of the important risk factors, the prevention and treatment of hyperlipidaemia has become an important problem for both community nutrition and clinical nutrition. Rather than various synthetic hypolipidaemic drugs, Chinese prefer traditional medicines or foods of popular legend for good and little side effect. The research into hypolipidaemic foods in China is predicated on this background and has shown considerable promise.

1. Dietary intervention for hyperlipidaemia

(1) Animal screening experiments. At the Institute of Hygiene and Environmental Medicine, in Tianjin, Prof Sun Mingtang and his colleagues first screened 84 kinds of Chinese food for hyperlipidaemic effects by animal experiment[3]. Male rats (220-270g) were used and a high-fat intake model was produced by feeding a ration containing lard 5%, cholesterol 1.5% and bile salt 0.5%. The test food was freeze dried and mixed with the high-fat ration at 10%. The experimental period used was 4 weeks. Serum cholesterol was determined once every week and liver cholesterol and fat were determined at the end of 4 weeks.

It was found that 23 test foods could prevent hypercholesterolaemia, and some were also effective in preventing the increase in liver cholesterol and fat. Individual foods were then studied further in humans. For example, in pair-fed rats, after feeding high the fat ration, mushrooms were found to lower the serum cholesterol. Then, 14 patients were given 10g mushroom daily, when both serum cholesterol and triglyceride decreased after one month, and, to a greater extent, after two and three months.

(2) Human intervention study with composite diet. 43 male hyperlipidaemics with serum cholesterol more than 230 mg% (6.0 mmol/L) and triglyceride more than 150 mg%

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Correspondence address: Professor Gu Jing-Fan, Professor of Nutrition, (c/o Chinese Nutrition Society), Institute of Hygiene and Environment Medicine, 1 Da Li Dao, Tianjin, 300050
Tel: +86-3-9014-9291; Fax: +86-1-301-1875

(1.7 mmol/L) were given a diet composed of hypolipidaemic foods screened, including beans, mushrooms, nuts and aquatic products. The diet was kept high energy (3600-4000 kCal) and high fat (36-43 fat - energy %), with 760-1000 mg cholesterol daily. Daily energy expenditure was 3200-3300 kcal. Serum cholesterol and triglyceride lowering was significant after one month and continued for the three months of observation[4].

The hypocholesterolaemic foods were:

Plant foods	Animal foods and seafoods
Broad bean*	Crucian carp
Chives	Greater croaker
Garlic	Mussel
Hyacinth bean**	Pork heart
Kidney bean**	Prawn
Mushroom	Scallop
Pea	Silvery pomfret
Peanut seed	Squid
Phaseolus L.**	Turtle**
Red bean*	
Spring onion**	
Soya bean	
Walnut seed	
Young soya bean*	

* also prevents an increase in liver cholesterol
** also prevents an increase in liver cholesterol and liver fat

2. Cereals

(1) Comparison of rice, corn, millet, oats and wheat flour. A hyperlipidaemic model was induced by feeding rabbits a basal ration plus 0.5% cholesterol. Cereals were given in place of 50% of the basal ration. The experimental period was 3 months. Compared to control, serum cholesterol was decreased with all 5 kinds of cereals. but serum HDLC (high density lipoprotein cholesterol) was increased only with millet, oats and wheat flour. Myocardial cholesterol was also lower with millet or oats. The percentage of atheroma area in the aorta was lower in the group given oats[5].

(2) Effect of naked oats. The effect of naked oats (*Avena stiva L. var. nuda Mordv.*) on blood lipids was studied in rats on a high lipid ration for 10 weeks. 6 g naked oats flour were given daily to rats. The serum TC (total cholesterol), TG (triglycerides), LDLC (low density lipoprotein cholesterol) and AI (atherogenic index) were significantly decreased while HDLC and AAI (anti-atherogenic index) increased[6].

(3) Clinical use of bitter buckwheat. Bitter buckwheat is used in traditional Chinese medicine for treating diabetes. With the high fat rat model, the hypolipidaemic effect of buckwheat was evident at 30 days[7]. Eight NIDDM patients with hyperlipidaemia were given buckwheat flour (26g/d) in the form of noodles for 30 days; both serum TC and TG were decreased as well as fasting blood and urine sugar[8].

(4) Wheat germ and maize germ. The hypolipidaemic effect of wheat germ was studied in a high fat model with quails, and the serum TC and LDLC were as low as those in a group given inositol nicotinate. The serum HDLC and the severity of fatty liver were even better than the latter[9]. Subsequently, 40-50 g maize germ flour was given to 83 hyperlipidaemic patients daily for two months. Serum TC and LDLC were decreased while HDLC and the relative activity of lecithin cholesterol acyltransferase (LCAT) increased compared with wheat flour[10].

3. Dietary fibre

(1) Comparison of different fibres. Dietary fibre of various types are known for their hypolipidaemic effects. We compared four kinds of dietary fibre (*konjac, pectin, algin and agar*) in the high fat rat model, and found that liver TC and volume density of liver cells decreased in the konjac and algin groups and number density of liver cells increased in the experiment at 9 weeks. There was little change in the pectin and agar groups[11,12]. The absorption of calcium and trace elements was not influenced by ingesting konjac[13].

(2) Human study of konjac. Konjac powder contains mainly *glucomannan.* 66 hyperlipidaemia patients were given 5 g konjac powder daily in the form of noodles, bread and cakes for 45 days. Their dietary intake of energy was 2260-2400 kCal, the fat 32-35%. Serum TG, TC, LDLC. HDLC and apo AI all improved, but apo B_{100} was not changed. Konjac foods are used in China in obese and diabetic patients; reduction in body weight, body fat and blood sugar have been reported[14].

(3) Use of "soy dregs" fibre. Soy dregs fibre contains 49.3% insoluble dietary fibre and 21.2% soluble dietary fibre. In an 8 week experiment, the rats fed with 8% soy dregs fibre had lower serum TC and LDLC compared with the control high fat group, but serum TG and HDLC were unchanged[15].

4. Beans

(1) Soybean. Male rats were given high fat ration containing 25% protein of three kinds, casein, soybean protein and peanut protein for 4 weeks. Serum TC, TG, VLDL + LDL were decreased while serum HDL and LCAT activity were increased in the groups of soybean protein and peanut protein compared with casein[16]. In another experiment, a high fat ration containing 18% defatted soybean flour was fed to rats for 2 months when serum TG decreased 23.8% more than the control[17]. Soybean protein increased the combination of LDL receptors to LDL in liver cells, and serum VLDL + LDL declined. Soybean protein increased LCAT activity, with accelerated removal of cholesterol from tissues.

(2) Soybean phospholipid. Male rats were given a high fat ration and 10% soybean phospholipid for 6 weeks. Serum and liver TC were decreased significantly compared with 10% lard. Serum HDLC and HDL_2C were increased while HDL_3C was not changed. Serum LCAT and plasma lipoprotein lipase (LPL) activity increased, but plasma hepato-endothelial lipase (HEL) activity decreased[18].

(3) Mung beans. Mung bean powder (70%) was given to rabbits fed with a high fat ration for 2.5 months. The increase of serum TC and lipoprotein was less than with the control[19]. With 6 months therapy, the lesions and the degree

of occlusion of coronary arterioles were less in the mung bean group than in the controls. When 115 hyperlipidaemia patients were given 30 g mung bean powder b.i.d. and the background diet was not changed, serum TC, TG and lipoprotein were decreased after 1- 3 months treatment[20].

5. Edible oils

(1) Commonly used edible oils. 12g *soybean oil, rice bran oil* or *rapeseed oil* was given daily to rabbits fed with the high lipid ration. The degree of occlusion of coronary arteries was less in all groups at the end of 3 months compared with control, but TC concentration of heart, liver and aorta was decreased only in the group fed soybean oil[21]. In another experiment, a ration containing 11% edible oil was given to rats together with a daily dose of 1g cholesterol; the serum TC and LDL at the end of 3 months were lowest and the serum HDL the highest in a group given sesame oil, the next most pronounced effects in the group given teaseed oil and, next soybean oil. Serum TC remained high in groups given peanut oil or lard. Serum MDA (malonyl dyaldehyde) was high in all groups because most edible oil is rich in PUFA, except for the MUFA - rich teaseed oil group in which serum MDA and fluorescence polarisation of biological membranes were low indicating better membrane fluidity[22].

(2) Rubber seed oil. The hypolipidaemic effect of rubber seed oil was studied in monkeys. 10 Rhesus monkeys were fed with the high fat ration and 20 ml rubber seed oil daily for 10 months; the serum and aortic TC were lower and serum HDLC higher than the control. The thickness of atheroma in aorta and the frequency and severity of coronary artery lesions were less[23]. There is less hyperlipidaemia in people taking rubber seed oil compared with those taking peanut oil[24].

Similar experimental animal studies showed hypolipidaemic effects of *grape seed oil* and *Suaede Salsa Pall seed oil* and similar arterial results were obtained[25,26].

(3) Fish oil. Male rats were fed the fat lipid ration and 1 ml concentrated fish oil which contained 59% EPA + DHA daily for 3 months. Serum TC was decreased nearly 50% and HDLC increased nearly 70% as compared with the high fat control[27]. Its therapeutic effect was shown in 204 hyperlipidaemic patients who took 5g fish oil (containing 1.2g EPA and 2.6g DHA) daily for 10 weeks. Serum TC, TG, and apo B declined and HDLC rose significantly. In vitro thrombosis was also reduced[28].

6. Fungi and algae

(1) Auricularia. Besides the common Chinese mushroom which is known for its hypolipidaemic effect, *Auricularia* is a group of edible fungus commonly used in China. The polysaccharide extracted from *Auricularia Polytricha Sacc* has been shown to have hypolipidaemic effect, if given to mice on a high fat diet, at daily doses of 30 or 50mg/ kg bw (body weight) for 10 days. Serum TC, TG, LDL decrease and HDLC increases compared with the high fat control. A similar effect was found in rats at higher dose, 100 or 150mg/ kg bw[29].

(2) Algae. *Enteromorpha Prolifera,* given at 10% of the high fat ration to male rats for 30 days, decreased serum TC, LDLC, VLDLC and increased HDLC compared with the high fat control[30]. *Kelp* has also been shown to lower serum TC after feeding 10% powder with a high fat ration for 4 weeks[31]. *Laminarin sulfate* has hypolipidaemic and anticoagulation effects clinically[32].

(3) Laver. The polysaccharide isolated from *Porphyra yezoensis Ueda* was given to a high fat rat model, 75mg/ kg bw/ day, for 8 days. Both serum TC and TG were decreased significantly as compared with the high fat control[33]. *Porphyra polysaccharide* also lowered blood sugar, was anticoagulant and anti-aging; increased myocardial contraction, enhanced serum protein synthesis, enhanced immune function and inhibited tumour growth in animal experiments.

7. Vegetables and fruits

(1) Celery. Rabbits were fed 0.1 kg celery/ kg bw/ d or 30 ml celery water extract/ kg bw/ d (containing 50g celery) besides a high fat ration for 30 days. Serum TG and LDL were lowered as compared with the control[34].

(2) Garlic. *(Allium sativum L).* Rabbits were fed 2g garlic per day in addition to a high fat ration for 30 days. Serum TC and the grade of aortic atheroma were reduced compared with the high fat control, but the garlic if stored over 7 months showed no effect[35]. Similar observations have been made on rabbits by giving 1 mg allicin/ kg bw/ day for 4 months, no matter whether the allicin was extracted or synthesised[36].

(3) Onion. On a high fat diet, there are significant differences in blood cholesterol between onion-eating and non-onion-eating subjects. In clinical observations on persons eating 50g onion a day for one month, 39 out of 43 cases with hypercholesterolaemia experienced a decline in cholesterol (91%) and 14 out of 25 cases with coronary artery disease had electrocardiographic improvement (56%)[37].

(4) Splintar pear. *(Rosa voxburghii Tartt). Splintar pear* is a wild fruit, rich in vitamin C (2400 mg%) and flavonoids. 6.4g pear juice/ kg bw/ d were fed to quails, weighing 80-100g, in addition to a high lipid ration for 12 weeks. Plasma TC and plasma TC/ HDLC were significantly lowered compared with the high lipid controls. The liver weight/ body weight (%) and arteriosclerosis incidence were also decreased[38].

(5) Kiwifruit also known as "Chinese gooseberry". *(Actinida chinensis Planch).* The beverage made from kiwifruit, which is a wild fruit, was given at 670 ml daily in 11 old men for 14 days while sugar-containing beverage was used as control in another 11 old men. Serum cholesterol as well as MDA was reduced at the end of the experiment, but serum triglycerides were unchanged[39].

8. Other foods

(1) Tea. The *polysaccharide* isolated from green tea has proved to have anti-hyperlipidaemic effects both in mice

and rats. Serum TC was lowered 17%, serum TG lowered 23%, LDL lowered 29% and HDL increased 26% if tea polysaccharide was given 45mg/ kg for 10 days in hyperlipidaemic rats[40]. Tea polysaccharide might increase the activity of LPL and so lower LDL[41]. Tea polysaccharide might combine with apo A-I and the conformation of apo A-I change to be more effective in activation of LCAT[42].

Tea *polyphenol* also has an effect in lowering TC, TG, LDLC and increasing HDLC in hyperlipidaemic rats if given 1% or 2% for 6 weeks. It also has an anticoagulant effect[43].

(2) Chromium containing food. After feeding hyperlipidaemic rats with Cr-enriched yeast containing 18μg Cr/ kg bw/ d for 80 days, there is a preventive effect against an increase in TC, TG, LDLC and decrease in HDLC, and a therapeutic effect if Cr-enriched yeast 10μg Cr/ kg bw/ d is fed 40 days[44]. Cr-enriched yeast can also decrease serum TC, TG, LDLC and increase HDLC in NIDDM patients with hyperlipidaemia[45]. Brown sugar contains more chromium, about 0.24-0.35 μg/ g, and its lowering effect on serum TC and TG is seen in hyperlipidaemic rabbits if fed 4g/ kg bw/ d for 75 days. It also reduces atheroma area and aortic thickness[46].

(3) Iodine-enriched eggs. Iodine-enriched eggs are prepared by feeding hens with iodine-enriched feed. Forty-nine hypercholesterolaemic patients were given one egg daily, containing 1400-1600μg iodine, for three months. Serum TC decreased. Similar effects were shown in lowering blood and urine sugar and lowering systolic blood pressure in NIDDM and in hypertensive patients respectively[47]. In another study, 46 patients with low HDL ate iodine-enriched eggs for 1-2 months and HDL increased[48].

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中國的降血脂食物

摘要

隨着近年來中國膳食模式的改變，高脂血症已成爲慢性退行性疾病．特別是心腦血管疾病發病機制的重要問題．作者從實驗動物和人體高脂血症的研究，鑒定了一些與傳統中國食物文化有關的降血脂食物和飲料．這些食物在膳食中缺乏時，也許會增加高脂血症患病率。

中國幾類具有降血脂的食物包括:
谷類: 燕麥，油麥，小米，蕎麥，小麥芽，玉米芽;
豆類: 大豆，菜豆，紫豆(Hyacinth)，紅豆，小豆，綠豆，Phaseolus L，大豆渣;
水産: 蝦，大黃魚，鯽魚，鯉魚，尤魚，淡菜，扇貝，銀鮭;
菌藻類: 香菇，藻朊，海草，紫菜;
蔬菜類: 大蒜，芹菜，洋葱，葱，細香葱，胡椒;
堅果和水果: 花生仁，胡桃仁，刺梨，彌猴桃;
油類: 大豆油，米麩油，茶籽油，橡膠籽油，葡萄籽油，魚油，大豆磷脂;
其他: 茶，紅糖，鉻强化酵母，碘强化蛋。

目前作者正探討一些在食物中有可能影響脂蛋白代謝的因素，以期獲得對脂類疾病的處理和預防的新方法。

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