CHOLESTEROL-LOWERING EFFECT OF SOY BEAN PRODUCTS ON HYPERCHOLESTEROLEMIC RATS
Abdel Latif, Mona A.1; A.A. Moustafa1 and S.A. Hafez2
1- Biochemistry Dept., Faculty of Agriculture, Cairo University, 2- Food Tech. Res. Inst. A.R.C. Giza, Egypt

ABSTRACT

This investigation was carried out to study the effect of soy bean products as a hypocholesterolemic agent. For this purpose an experiment was carried out by using 60 rats which were divided into 10 groups (6 rats for each group). The daily gain in body weight, food intake and food efficiency were determined. It was found that the addition of 10% soy bean to hypercholesterolemic diet decreased total lipids, total cholesterol and triglycerides by 1.75%, 34.1% and 154.2% respectively as compared with the hypercholesterolemic rats. The other soy bean diets also significantly decreased all these parameters but in different degrees. HDL-cholesterol, LDL-cholesterol and the ratio of total cholesterol to HDL-cholesterol were also calculated in rat serum. The ratio of total cholesterol/HDL-cholesterol was decreased in hypercholesterolemic rats by giving soy bean diets that proved the beneficial effect of this seeds as hypocholesterolemic agent.

INTRODUCTION

There is increasing evidence that consumption of soy protein and isoflavones in place of casein lowers low-density lipoprotein (LDL) (Sirton et al., 1995 and Nagata et al., 1998) cholesterol and may provide other cardiovascular benefits such as antioxidant properties. (Kapiotis et al., 1997 and Exner 2001) However, even after a meta-analysis of 38 controlled clinical studies suggesting its potential role in the reduction of total and LDL cholesterol (Anderson et al., 1995), no recommendation was made to include soy protein in the American Heart Association dietary guidelines (Krauss et al., 1996 and Erdman, 2000).

Soy protein is an edible component of soybeans and contains all the essential amino acids in sufficient amounts to be considered as a complete protein. (Bricarello et al., 1999 and Houston, 1996) In addition to protein, other components occur naturally, such as isoflavones, saponins, and fibers.

Many attempts have been made to elucidate the mechanisms involved in the multiple beneficial effects when following soy diets. These studies have suggested an inhibition of cholesterol absorption at the small intestine by soy protein (Huff and Carroll, 1980).

A reduced rate of saponins-mediated bile salt absorption, and an antioxidant effect on lipids associated with soy protein with or without isoflavones (Kapiotis et al., 1997 and Damasceno et al., 2000) as well as the higher increase of high-density lipoprotein (HDL) cholesterol serum levels appears to be associated with the presence of isoflavones in the soy protein. (Anthony et al., 1998) In addition, an activation of peroxisome proliferator-activated receptors (PPARs) was recently reported, which may explain these interesting effects of soy protein on lipid metabolism (Mezel el al., 2003).
Abdel Latif, Mona A. et al.

Nagata et al., (1998) studied a hypercholesterolemic effect of soy protein, a substantial increase in HDL cholesterol and a reduced lipid peroxidation. In fact there were different results with the soy protein diet, which can be attributed to variations in soy components such as the protein content and the amount of isoflavones, (Anthony et al., 1998) saponin, (Sidhu and Oakenfull, 1986) and fiber (Potter et al., 1993 and Potter, 1995). Interestingly, on the basis of the meta-analysis reported by Anderson et al., 1995, hypercholesterolemic patients appeared to have the highest benefit after the use of soy protein. However, this finding was not confirmed by another study (Wong et al., 1998).

After comparing the effects of soy milk with those of cow milk in severe hypercholesterolemic patients, Siritori et al., 1999 found a significant reduction in total and LDL cholesterol levels, thus confirming the benefits of soy milk even in patients with substantially elevated plasma cholesterol and only partly replacing the animal protein in the diet.

These abovementioned researches suggest a potential role of soy milk and its derivatives in the prevention of cardiovascular disease.

Soy protein consumption has been shown significantly decrease in serum concentrations of total and LDL cholesterol and triacylglycerids (Vigna et al., 2000 and Scheiber et al., 2001). Many components associated with soy protein, eg. isoflavones (Jenkins et al., 2002), saponins (Oakenfull, Sidhu, 1990), and β-conglycinin (7Sglobulin), are reported to have a lipid-lowering effect (Adams et al., 2004).

The aim of the present work was to evaluate the hypocholesterolemic effects of soy bean products (soy flour, soy bean, soy tofu and soy milk) on the hypercholesterolemic rats.

MATERIALS AND METHODS

1-Soy bean products

Soy bean seeds and other products where obtained from Food Technology Research Institute (FTRI), Agriculture Research Center (ARC).

2-Biological experiment

Sixty male albino rats (100-110g) were obtained from the National Research Center, Dokki, Giza. Animals were housed in individual cages with screen bottoms and fed on basal diet (50% starch, 20% casein, 10% corn oil, 5% cellulose, 4% salt mixtures and 1% vitamin mixtures) for eight days (6 for each). The first group was fed on the basal diet for 4 weeks and was considered as a positive control group. The second group was fed on hypercholesterolemic diet (H-diet) for 4 weeks (basal diet supplemented with 1% cholesterol + 0.5% bile salts + 15% sheep tail fat). It was the control of hypercholesterolemia (negative control). The third group was fed on H-diet, containing 10% soy flour. The fourth group was fed on H1-diet, containing 5% soy flour. The fifth group was fed on H2-diet, containing 10% soy bean. The sixth group was fed on H3-diet, containing 5% soy bean. The seventh group was fed on H4-diet, containing 10% soy tofu. The eighth group was fed on H5-diet, containing 5% soy tofu. The ninth group was fed on H6-diet, containing

7744
10% soy milk. The tenth group was fed on \( H_2 \)-diet, containing 5% soy milk. During the whole experiments, rats were kept separately in well aerated cages, diet and water were supplied \textit{ad libitum}. Each rat was weighed every two days and the food intake was also recorded. At the end of experiment, rats were fasted for 18 h and killed by decapitation, and the blood of each rat was collected in tubes and centrifuged at 3000 rpm for 10 minutes to obtain the serum. Serum sample was stored at -20 °C until analysis.

3-Biochemical analysis

Total lipids in serum were determined according to Knight \textit{et al.}, (1972). Cholesterol and triglycerides were estimated by standard methods according to Allain \textit{et al.}, (1974) and Fossati and Prencipe (1982), respectively. Serum HDL-cholesterol was determined in the supernatant after treatment with a mixture of phosphotungstic acid and magnesium chloride (Lopes – Virela \textit{et al.}, 1977). Serum LDL-cholesterol was determined by the method of Steinberg (1981).

4-Statistical analysis

Statistical analysis was carried out according to Fisher (1970). LSD (Least squares difference) test was used to compare the significant differences between means of treatment (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

1-Food intake

Food intakes of rats fed normal and hypercholesterolemic diet supplemented or not with soy bean diets are shown in Table (1). Food intake of rats fed hypercholesterolemic diet was significantly lower than that of positive control. Results concerning food intake supported the hypothesis that the digestion of food constituents may be inhibited by addition of bile salts (Aoyama \textit{et al.}, 1975 and Harama \textit{et al.}, 1988).

2-Body weight gain and food efficiency

Rats fed on a normal diet (Table 1) showed the highest daily gain in body weight (2.3g), while rats fed on hypercholesterolemic diet (Negative group) showed a significantly lower daily gain in body weight (1.59g).

Addition of soy bean products to the hypercholesterolemic diet significantly increased body weight gain from 21.73g in negative control to 44.52, 36.95, 33.13 and 27.17g by addition 10% soy flour, 10% soy bean, 10% soy tofu and 10% soy milk respectively. Also, the daily in body weight was increased in the same period from 0.78g (negative control) to 1.59g (by addition 10% soy flour) which is in close value to that of positive control (2.3g).

As it is well known that the hypercholesterolemic diets disturb the metabolic process in animal organism, which led to decrease gain in body weight and food efficiency (Esmaieil \textit{et al.}, 1993).
Abdel Latif, Mona A. et al.

In the present experiments, the diets containing soy flour, soy bean or soy tofu stimulated both body weight gains and food efficiency.

It is worthy to mention that food efficiency is strongly correlated with daily gain of body weight and food consumption as cited by Squibb (1959). who calculated it according to the equation:

Food efficiency = gain in body weight / food intake.

Food efficiency also followed the same trend where increased from 0.44g (negative control) to 0.64g (by addition 10% soy flour) which is a value close to that of positive control 0.74g. It is clear that the addition of soy flour to the hypercholesterolemic diet has a beneficial effect on daily gain of body weight and food efficiency as compared with the negative control.

The present results concerning food efficiency are in agreement with those reported by Kahlon et al. (1983) who found that food efficiency was affected by diet containing hypercholesterolemic agents.

Table (1): Body weight gain (g) and food efficiency on rats fed hypercholesterolemic diet supplemented with Soy Bean Products

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Daily food intake</th>
<th>Initial body weight(g)</th>
<th>Final body weight(g)</th>
<th>Body weight gain(g)</th>
<th>Daily body weight gain(g)</th>
<th>Food efficiency values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated group</td>
<td>±0.036</td>
<td>±1.325</td>
<td>±1.22</td>
<td>±2.538</td>
<td>±0.09</td>
<td>±0.032</td>
</tr>
<tr>
<td>Positive control</td>
<td>±0.046</td>
<td>±1.39</td>
<td>±1.33</td>
<td>±2.538</td>
<td>±0.09</td>
<td>±0.032</td>
</tr>
<tr>
<td>Hypercholesterolemic group (Negative control)</td>
<td>±0.046</td>
<td>±1.193</td>
<td>±1.106</td>
<td>±2.29</td>
<td>±0.06</td>
<td>±0.05</td>
</tr>
<tr>
<td>Soy flour 10%</td>
<td>±0.056</td>
<td>±0.929</td>
<td>±1.17</td>
<td>±1.705</td>
<td>±0.06</td>
<td>±0.025</td>
</tr>
<tr>
<td>Soy flour 5%</td>
<td>±0.106</td>
<td>±1.17</td>
<td>±0.53</td>
<td>±0.51</td>
<td>±0.07</td>
<td>±0.025</td>
</tr>
<tr>
<td>Soy bean 10%</td>
<td>±0.075</td>
<td>±0.451</td>
<td>±0.312</td>
<td>±0.477</td>
<td>±0.02</td>
<td>±0.01</td>
</tr>
<tr>
<td>Soy bean 5%</td>
<td>±0.075</td>
<td>±0.451</td>
<td>±0.312</td>
<td>±0.477</td>
<td>±0.02</td>
<td>±0.01</td>
</tr>
<tr>
<td>Soy tofu 10%</td>
<td>±0.075</td>
<td>±0.451</td>
<td>±0.312</td>
<td>±0.477</td>
<td>±0.02</td>
<td>±0.01</td>
</tr>
<tr>
<td>Soy tofu 5%</td>
<td>±0.075</td>
<td>±0.451</td>
<td>±0.312</td>
<td>±0.477</td>
<td>±0.02</td>
<td>±0.01</td>
</tr>
<tr>
<td>Soy milk 10%</td>
<td>±0.036</td>
<td>±1.094</td>
<td>±1.815</td>
<td>±1.961</td>
<td>±0.07</td>
<td>±0.03</td>
</tr>
<tr>
<td>Soy milk 5%</td>
<td>±0.047</td>
<td>±1.064</td>
<td>±1.865</td>
<td>±1.961</td>
<td>±0.08</td>
<td>±0.03</td>
</tr>
</tbody>
</table>

LSD (p<0.01) a, b, c, d and e the means different superscripts in each column are significantly different at (p<0.01). Each value represents the mean of 6 rats ± S.E.

3. Total lipids, triglycerides and total cholesterol

Total lipids, triglycerides and total cholesterol were determined in the rat serum to evaluate the role of soy bean diets on lipid metabolism. The results are shown in Tables (2&3).
### Table 2: Effect of soya bean products on total lipids, triglycerides by feeding rats for 4 weeks

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total lipids</th>
<th>%</th>
<th>Triglycerides</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated group (Positive control)</td>
<td>470.74</td>
<td>± 6.62</td>
<td>100</td>
<td>± 23.92</td>
</tr>
<tr>
<td>Hypercholesterolemic Group (Negative group)</td>
<td>630.59</td>
<td>± 6.564</td>
<td>133.95</td>
<td>± 1</td>
</tr>
<tr>
<td>Soy Flour 10%</td>
<td>510.72</td>
<td>± 0.526</td>
<td>108.49</td>
<td>± 8.773</td>
</tr>
<tr>
<td>Soy Flour 5%</td>
<td>561.606</td>
<td>± 6.606</td>
<td>112.9</td>
<td>± 1.45</td>
</tr>
<tr>
<td>Soy bean 10%</td>
<td>516.79</td>
<td>± 6.635</td>
<td>110.2</td>
<td>± 6.168</td>
</tr>
<tr>
<td>Soy bean 5%</td>
<td>543.3</td>
<td>± 5.49</td>
<td>115.4</td>
<td>± 10.16</td>
</tr>
<tr>
<td>Soy Tofu 10%</td>
<td>500</td>
<td>± 5.81</td>
<td>119.57</td>
<td>± 0.945</td>
</tr>
<tr>
<td>Soy Tofu 5%</td>
<td>582.68</td>
<td>± 6.31</td>
<td>120.54</td>
<td>± 1.344</td>
</tr>
<tr>
<td>Soy milk 10%</td>
<td>550.99</td>
<td>± 6.42</td>
<td>117.48</td>
<td>± 0.757</td>
</tr>
<tr>
<td>Soy milk 5%</td>
<td>586.20</td>
<td>± 5.43</td>
<td>119.24</td>
<td>± 1.236</td>
</tr>
</tbody>
</table>

**LSQ (p<0.05)**

a, b, c, d and e the means different superscript in each column are significantly different at (p<0.05). Each value represents the mean of 6 rats ± S.E.

The amounts of total lipids, triglycerides and total cholesterol, in positive control were given the arbitrary value 100 and the increase and decrease in lipid fraction in negative control and after addition of soy bean diets were related to 100. Data of total lipids showed an increase in serum of hypercholesterolemic rats from 470.74 mg/dL in positive control to 630.59 mg/dL in negative control. By given the value 100 to positive control, the increase in total lipids was 133.85% for negative control.

On the other hand, serum triglycerides and total cholesterol were also significantly increased in negative control by (341.45%) and (368.01%) respectively as compared with positive control (Table 2 & 3).

The effect of soy flour diets administration during 4 weeks on lipids pattern is recorded also in Tables (2 & 3). The present results indicated that, the levels of serum total lipids and triglycerides were significantly decreased by 25.46% and 227.99% in rats fed 10% soy flour, respectively. Also, a significant decrease (355.15%) in total cholesterol by 10% soy flour was observed. A concentration of 10% soy bean, 10% soy tofu and 10% soy milk caused also a significant decrease by percentage of (23.75%), (14.38%) and (16.47%) for total lipids, (224.85%), (150.35%) and (149.08%) for
triglycerides and (341.09%), (330.64%) and (254.91%) for total cholesterol respectively, relatively to negative control.

Data in Table (2 & 3) reveal the effect of soy bean diets treatment on serum total lipids, triglycerides and total cholesterol of hypercholesterolemic rats. It is clearly shown that the administration of soy flour (5%) for 4 weeks caused a significant decrease in serum total lipids by 21.05% in serum triglycerides by 20.78% and in cholesterol by 352.53% relatively to negative control.

These results agreed with that findings reported by Liliya et al., (2004).

4-Serum lipoprotein cholesterol

The changes in high density lipoprotein-cholesterol (HDL-C), low density lipoprotein-cholesterol (LDL-C) and the ratio of total cholesterol to HDL-C (risk ratio) of hypercholesterolemic rats fed on different soy bean diets were investigated. The results are summarized in Table (3). The data revealed no significant differences were found between high density lipoprotein-cholesterol (HDL-C) values in all treatments even in negative control.

Table (3): Effect of soy bean products on total, HDL and LDL-cholesterol and risk ratio by feeding rats for 4 weeks

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total cholesterol</th>
<th>HDL-cholesterol</th>
<th>LDL-cholesterol</th>
<th>Risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/dL</td>
<td>%</td>
<td>mg/dL</td>
<td>%</td>
</tr>
<tr>
<td>Untreated group (Positive control)</td>
<td>97.93 ± 0.88</td>
<td>100</td>
<td>51.47 ± 0.74</td>
<td>100</td>
</tr>
<tr>
<td>Hypercholesterolemic Group (Negative group)</td>
<td>301.63 ± 1.18</td>
<td>308.01 ± 0.47</td>
<td>18.73 ± 0.47</td>
<td>36.36</td>
</tr>
<tr>
<td>Soy Flour 10%</td>
<td>107.87 ± 1.23</td>
<td>110.15 ± 1.18</td>
<td>32.54 ± 0.47</td>
<td>63.73</td>
</tr>
<tr>
<td>Soy Flour 5%</td>
<td>110.5 ± 1.7</td>
<td>112.73 ± 1.12</td>
<td>29.73 ± 0.47</td>
<td>57.76</td>
</tr>
<tr>
<td>Soy Bean 10%</td>
<td>121.69 ± 0.95</td>
<td>124.17 ± 1.23</td>
<td>32.1 ± 0.95</td>
<td>62.17</td>
</tr>
<tr>
<td>Soy Bean 5%</td>
<td>125.77 ± 1.17</td>
<td>128.43 ± 1.23</td>
<td>31.23 ± 0.76</td>
<td>60.68</td>
</tr>
<tr>
<td>Soy Tofu 10%</td>
<td>131.33 ± 0.83</td>
<td>134.82 ± 0.87</td>
<td>30.47 ± 0.87</td>
<td>59.2</td>
</tr>
<tr>
<td>Soy Tofu 5%</td>
<td>149.37 ± 1.15</td>
<td>152.53 ± 1.07</td>
<td>27.27 ± 1.15</td>
<td>52.98</td>
</tr>
<tr>
<td>Soy milk 10%</td>
<td>206.23 ± 0.7</td>
<td>210.35 ± 1.35</td>
<td>26.23 ± 0.75</td>
<td>51</td>
</tr>
<tr>
<td>Soy milk 5%</td>
<td>233.89 ± 1.12</td>
<td>228.43 ± 1.11</td>
<td>22.77 ± 0.99</td>
<td>44.1</td>
</tr>
</tbody>
</table>

LSD (p=0.05) a, b, c, d and e the means different superscript in each column are significantly different at (p<0.01). Each value represents the mean of 6 rats ± S.E.

In the present experiment, values of HDL alone could not be taken as criteria for hypercholesterolemia. Values of LDL must also be taken into consideration. The serum LDL-C was increased from 41.53 mg/dL in positive
control to 219.4 mg/dL in negative control. It could be noticed that in hypercholesterolemic rats LDL-C was increased to 528.29%.

Addition of soy bean products on diets significantly decreased LDL-C in rats. It was increased to 219.4 mg/dL in negative control and was decreased again to 148.17, 132.8, 94.47 and 83.1 mg/dL in rats fed 10% soy flour, 10% soy bean, 10% soy tofu and 10% soy milk, respectively. These values are in close to the positive control value. The risk ratio which equal to the ratio of total-cholesterol/HDL value, is a good indication for hypercholesterolemia. This ratio was increased to 16.1 in the negative control as compared with the positive control 1.9. It was decreased to 3.29, 4.67, 4.33 and 7.84 in rats fed 10% soy flour, 10% soy bean, 10% soy tofu and 10% soy milk, respectively.

The increase in LDL-cholesterol may be due to the increase in hepatic VLDL production and significant decrease in hepatic LDL receptor activity. These results are in agreement with those of Sirtori, et al., (1995); Nagata, et al., (1996); Anderson, et al., (1995); Liliana, et al., (2004) and Siyan, Zhan and Suzanne, (2005).

Hypercholesterolemia and atherosclerosis result from the accumulation of LDL in the arterial wall and from the cellular response of wall compounds to injury. Oxidative modification of LDL is a key and early event in the pathogenesis of atherosclerosis (Slenberg, et al., 1981). Several dietary components of soy bean compounds had been shown to lower LDL-C level and inhibit the oxidative modification of LDL (Huff and Carroll, 1980).

REFERENCES


determination in high density lipoproteins separated by three different
antidiabetic and hypolipidemic effects through the PPAR pathways in
cholesterol concentration is associated with high intake of soy products
Oakenfull, D.G. and Sidhu, G.S. (1990). Could saponins be a useful
Potter, S.M. (1995). Overview of proposed mechanisms for the
cholesterol in men by consumption of baked products containing soy
Schilber, M.D.; Liu, J.H.; Subbiah, M.T.; Rebar, R.W. and Setchell, K.D.
(2001). Dietary inclusion of whole soy foods results in significant
reductions in clinical risk factors for osteoporosis and cardiovascular
Sidhu, G.S. and Oakenfull, D.G. (1986). A mechanism for the
the addition of high-protein soya milk v. cows' milk to the diet of
patients with severe hypercholesterolaemia and resistance to or
protein containing isoflavones on the lipid profile. Am J Clin Nutr 81:
397-408.
to atherogenesis. In lipoproteins. Atherosclerosis and Coronary Heart
Disease, 1(2) 31.
soy-treated postmenopausal women: a double blind, placebo-
of soy protein in normocholesterolemic and hypercholesterolemic men.
تأثير خفض مستوى الكوليسترول بواسطة وجبات مختلفة من وجبات فول الصويا

وذلك مع تقليد التجارب المرتقبة في مستوى الكوليسترول

من عيد الأضحى عبد الله تنفيذ، عمرو أحمد مصطفى و صلاح عبد المنعم حافظ

1- قسم الكيمياء الحيوية - كلية الزراعة - جامعة القاهرة - الجيزة - مصر

2- معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية

اجريت الدراسة بهدف دراسة تأثير استخدام وجبات مختلفة تحتوي على بعض منتجات فول الصويا كمصدر خفض مستوى الكوليسترول الدم. حيث أجريت تجربة بيولوجية باستخدام 10 فار قسمت إلى 10 مجموعات (1 فار في كل مجموعة). المجموعة الأولى غذت على طريقة قياسية لمدة 4 أسابيع. والمجموعة الثانية تم تقسيمتها على طريقة مرتبطة في محتوى الكوليسترول لمدة 4 أسابيع واستخدام الزيادة مستوى الكوليسترول في الدم. المجموعة الثالثة غذت على طريقة مرتبطة في الكوليسترول وتحتوي على 10% من كيلو السويا و المجموعة الرابعة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 5% من كيلو السويا والمجموعة الخامسة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 10% من كيلو السويا والمجموعة السادسة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 15% من كيلو السويا والمجموعة السابعة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 5% من كيلو السويا والمجموعة الثامنة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 20% من كيلو السويا والمجموعة التاسعة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 15% من كيلو السويا و المجموعة العاشرة غذت على طريقة مرتبطة الكوليسترول وتحتوي على 5% من كيلو السويا. تم تدريج الزاء في وزن الجسم والذات المكمل و مدى الامتصاص منه. تم تدريج محتوى الليبيدات الكلية و محتوى الكوليسترول الكلي و الجليسيريدات الثلاثية في مصل الدم، وجد أن المجموعة التي تناولت وجبات فول الصويا بنسبة 10% أعطت انخفاض معنوي في محتوى الليبيدات بنسبة 7.5% و الكوليسترول بنسبة 13.2% و الجليسيريدات الثلاثية بنسبة 12.5% مقارنة بالفطور القياسي مرتبطة في مستوى الكوليسترول. و أيضا حدد انخفاض معنوي كللي المجموعات التي تناولت وجبات فول الصويا الأخرى ولكن بدرجات مختلفة. كذلك تم تقدير الكوليسترول الاليسيرينيات المرتبطة الكثافة و الكوليسترول النبضي الاليسيرينيات منخفضة الكثافة و النبضي من (المستوي الكوليسترول الاليسيرينيات مرتبطة الكثافة)، أظهرت النتائج انخفاض معنوي في النسبة بين الكوليسترول الكلي و الكوليسترول الاليسيرينيات مرتبطة الكثافة. لذلك يوصى البحث باستخدام وجبات فول الصويا التي أدت أثرها النافع كمصدر خفض لمستوى الكوليسترول الدم.