Review Article

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The Association between Non Soy Legume Consumption and Cardiovascular Risk Factors

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ABSTRACT

BACKGROUND AND OBJECTIVE: Cardiovascular disease (CVD) is a main cause of mortality throughout the world. CVD is related to life style. Legumes are one of the dietary factors that have nutritional and functional factors and play an important role in attenuating CVD risk factors. Legume consumption (at least 4 times a week) is associated with 22% lower risk for CHD and 11% lower risk for CVD. In this paper, we reviewed the presented articles about non soy legumes and CVD risk factors.

METHODS: We used PubMed search engine for this review and searched words including legume intake/consumption, bean/pea consumption, CVD/cardiovascular risk factors and inflammation in All Field. We achieved 346 papers. After limiting repeated articles and studies about soy and soy isoflavonoids, peanut, nuts, animal studies, children studies, cancer, renal disease and allergy, finally we reviewed 30 papers in this issue.

FINDINGS: Legume consumption can improve blood lipid profile. In addition, legume ingestion has positive potential effect on blood glucose levels, blood pressure, inflammation status and anthropometric indices. It seems that legumes have more beneficial effects on lipid profile than other CVD risk factors. However, the effects of legumes on other risk factors are important and needs more investigations.

CONCLUSION: Increasing non soy legume consumption is an appropriate approach for improving CVD risk factors and thus can reduce the incidence of CVD events among societies.

KEY WORDS: *Lipid Profile, Glycemic Indices, Inflammation Status.*

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Introduction

Cardiovascular Disease (CVD) is the leading cause of death in developed and developing countries (1, 2). According to the World Health Organization (WHO), heart diseases are rapidly becoming a widespread problem worldwide (3). In the early 20th century, CVD accounted for less than 10% of the deaths worldwide whereas it is currently responsible for 30% of all the deaths (4). In 2005, 17.5 million deaths from CVD were recorded in different parts of the world. It is expected that in 2015, this figure will reach 20 million deaths per year (3). CVD is the forerunning cause of 80% of all deaths in developing countries (5) and it is highly prevalent in Iran. Currently, most people in Iran are likely to have at

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least one of the risk factors of CVD. These risk factors include dyslipidemia, obesity, diabetes, high blood pressure, poor diet, low physical activity and smoking (3,6). CVD is a lifestyle-related disease and positive changes in diet and physical activity in this field will result in speedy improvements (7). Diets can reduce or increase the CVD risk factors substantially (1). Such dietary factors as consuming red meat (8), saturated fat (9-11), high energy density (12, 13) and prepared foods (14) increase the risk of CVD. On the other hand, consuming fruits and vegetables (15), low-fat dairy products (16), skimmed milk (17), soybeans (18, 19) and diversity in food intake (20) all have a protective effect against CVD risk factors. Legumes are a food factor with a large number of benefits in reducing CVD risk factors. They have a remarkable nutritional and functional role in promoting health and disease treatment. Legumes are also known to greatly reduce the CVD risk factors. The properties in legumes resulting in the prevention of CVD include vegetable protein, fiber, oligosaccharides phytochemicals, minerals and other bioactive compounds such as saponins and polyphenols (21). It is proven that consuming 1.5 cups of beans or peas per day leads to an increased intake of fiber, protein, folate, zinc, iron, magnesium and less saturated fatty acids and total fat (22) all of which will enormously reduce the risk of CVD. The results of a cohort study indicated that legume consumption is inversely associated with the risk of Coronary Heart Disease (CHD) and CVD. This association continued after adjusting for CVD risk factors and it was revealed after about 19 years of follow-up that consuming legumes 4 or more times a week reduces the risk of CHD up to 22% as well as the risk of CVD up to 11% compared to smaller intakes of legumes (e.g once a week) (23). Furthermore, another study suggests that taking a daily serving of beans is inversely associated with the risk of myocardial infarctions (adjusted for total energy intake, saturated fatty acids, trans fats, polyunsaturated fatty acids, cholesterol, history of diabetes, hypertension, upper abdominal obesity, physical activity, income, smoking and alcohol). Although a daily serving of beans reduces the risk of heart attack up to 38%, further protective effects were not observed with increased daily intakes (24). Cohort results suggest that people who eat more beans also receive more total energy, rice, fruit, vegetables, fish, potassium, calcium, carbohydrates, polyunsaturated fatty acids and saturated fatty acids, fiber and isoflavones. However, among all of the above there is an inverse relationship between isoflavone intake and the risk of stroke and heart disease in postmenopausal women (1). The results of another cohort study showed that increasing the intake of fruits, vegetables and legumes to 80 grams per day is likely to reduce deaths caused by any factors as much as up to 6%. In separate analyzes conducted, vegetables and legumes were significantly associated with the reduced risk of death in any case. However, there was no such association concerning fruits. Another finding in this regard states that a higher intake of 20 grams of legumes per day could significantly reduce CVD mortality in patients with diabetes (25). Metabolic syndrome is associated with an elevated risk of chronic diseases such as CVD and diabetes. Currently, about 30% of Iranian adults have metabolic syndrome. The results of a study conducted on 2457 participants of 19-84 years of age showed that fiber cereal, fruit and legumes are inversely associated with the risk of metabolic syndrome in adults in Tehran, Iran. However, this particular relationship could not be found in fiber vegetables and nuts (26). Another study followed 59,485 Japanese men and women in an age range of 40-79 years old for 13 years. Eventually, they concluded that intake of beans has an inverse correlation with deaths from CVD and total mortality. However, it reduced after adjusting for fruit and vegetables (27). In the light of the aforementioned, the aim of this paper was to review the existing studies on the consumption of non-soy legumes and the impacts on CVD risk factors.

Methods

Using the PubMed search engine and the All Field, keywords such as ‘legume consumption/intake’ and ‘bean/pea consumption’ and their combination with words like ‘CVD/cardiovascular risk’ and ‘inflammation’, 346 articles were collected in total. By removing duplicate articles and those focusing on soy, soy isoflavones, cancer, kidney disease, allergies, peanuts, nuts, animal studies and studies of children, finally 30 articles were reviewed. The review articles were used in this context where needed.

The Effects of Legumes on Blood Lipid Profile: Almost all the studies which have examined the effects of legumes on blood lipid profile express consistent results indicating that legume intake is able to improve

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the blood lipid profile relatively. Experimental results also suggested that compared to the healthy American diet, consuming 1.5 servings per 1000 kcal intake of beans per day significantly reduces serum total cholesterol and low-density lipoprotein (LDL) cholesterol in men at high risk of colorectal cancer. In another case, insulin-resistant subjects showed a greater reduction in high-density lipoprotein (HDL) and TG/HDL through bean consumption. Moreover, insulin-sensitive individuals using beans showed a significant, additional reduction in the total cholesterol, LDL, TC/HDL and LDL/HDL. In this study, insulin-sensitive patients who consumed beans benefitted greatly as to reduce the risk of CVD with regards to the lipid profile as well (28). Further experimental results indicated that consuming 728 grams of pea per week could help reduce the total cholesterol as well as LDL in healthy adults from 30 to 70 years old (29). In another study, 113 patients with a Body Mass Index (BMI) larger than or equal to 28, had to consume 2 daily servings of legume and 4 servings of whole grains for 18 months as an alternative to the refined carbohydrates. After the completion of the study, triglyceride levels decreased in both intervention and control groups (30). Another experimental research conducted in 2009 studied the impact of four hypocaloric diets on 35 obese men. The four diets used were as follows:

1) control diet
2) legume diet
3) high-fat fish diet
4) high-protein diet

After 8 weeks, HDL dropped in all groups except for in the high-fat fish diet. In the legume diet, on the other hand, a remarkable decrease was seen in the total cholesterol and LDL (31). In this regard, an 8-week study on 30 obese subjects with an average BMI of 32 showed that a hypocaloric diet (30% - energy costs) which was also rich in legumes (one serving per day, 4 days a week) resulted in a considerable reduction in the total cholesterol (32). In another crossover study, 9 patients randomly went on the control diet and diets with the same energy but with 120 grams of legume for 6 to 7 weeks. After the completion of the study, serum LDL-cholesterol concentrations in the legume diet were noticeably lower. Furthermore, bile acids saturation index with 18%-cholesterol showed a significant increase in the group consuming legumes. For another thing, the reabsorption of bile acids in the legume consumption group was significantly lower. The results of a meta-analysis conducted on 10 random clinical trial studies showed that non-soy legume consumption, compared with the control group, brings about a considerable decrease in the concentration of LDL and total cholesterol. All the studies reviewed in the meta-analysis of randomized intervention studies that used non-soy legumes were compared with the control group. They had the minimum duration of 3 weeks and reported blood lipid profile changes in the intervention and control groups (34). By contrast, another experiment found that the consumption of legumes did not have any effects on the lipid profile. In this study, 23 overweight patients with high cholesterol consumed 50 grams of chickpea flour per day for 28 days (about 1.5 cups of peas per day) in the form of a cookie. However, in the end, the chickpea flour with refined wheat flour did not prove to have any impacts on the lipid profile (35).

The Effect of Legume Consumption on Glucose and Insulin: Studies on using legumes and the glucose and insulin level express different results. A number of studies have shown the beneficial impacts of legumes on the blood glucose levels while some have not noticed any effects and even fewer have reported adverse effects. The results of a prospective cohort study on middle-aged Chinese women showed that the consumption of legumes and soy beans is inversely associated with the risk of type 2 diabetes (36). For another thing, the consumption of whole grains and legume powder instead of refined rice decreased glucose to 14% and insulin to 24% in patients with coronary artery disease and those without diabetes. In addition, it reduced fasting glucose concentrations in patients with CHD and diabetes. In this experiment, the diet composed of 66.6% whole grains, 22.2% legume powder, 5.6% seeds and 5.6% vegetables (37). The results of another study conducted on 19 middle-aged people stated that after taking just one serving of peas (200 grams cooked and dried peas) instead of white bread and wheat, the sugar level lowered significantly within 30 and 60 minutes after the consumption. Moreover, the amounts of plasma insulin and homeostasis model assessment (HOMA) were lower after 120 minutes. However, the long-term effects of eating peas (consumption of 140 grams canned peas and bread with 30% chickpea flour compared with wheat-based diet for 6 weeks) on plasma glucose and insulin, HOMA in fasting status

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and after glucose load was insignificant (38). For another thing, the consumption of 130 grams of baked beans for 12 weeks did not prove to have any effects on the serum glucose in people with metabolic syndrome (7). The results of a trial clinical study showed that a low GI diet rich in legumes causes a significant increase in fasting blood glucose and no change in insulin concentrations in the men who are at a high risk of colorectal cancer. In addition, the presentation of the results based on the subjects' resistance and/or sensitivity to insulin showed that in individuals sensitive to insulin, a diet rich in legumes leads to an insignificant increase in fasting blood glucose and insulin concentrations. On the other hand, in individuals resistant to insulin marginal increase in fasting blood glucose and insignificant increase in blood sugar were reported (39).

The Effects of Legumes on Blood Pressure: Compared with lipid profile and blood glucose levels, fewer studies have examined the relationship between the consumption of legumes and blood pressure. NHANES 1999-2002 data analysis results indicated that people who consumed roasted beans (baked beans) have lower systolic blood pressure despite higher sodium intake (40). The results of another experimental study also stated that a diet with energy constraints rich in legumes leads to a significant decrease in the systolic blood pressure in obese and overweight individuals (21). The results of an 18-month experiment on 113 patients with a BMI greater than or equal to 28 claimed that taking 2 servings of legumes and 4 servings of whole grains per day results in a lower blood pressure compared to the time before the intervention (30).

The Effects of Grains on Inflammatory Status: Fewer studies have examined the relationship between the consumption of legumes and the inflammatory markers. In this regard, the results of an experimental study on 64 men who were at a high risk of colorectal cancer showed a marginal decrease in the concentration of C-Reactive Protein (CRP) and sTNFR I and II (soluble tumor necrosis factor-α receptors I and II) compared to the pre-intervention regime as a result of legume consumption. This finding accounted for the largest decrease occurred in the numerical value of 20% for CRP (39). The results of another experimental study also supported this finding. In other words, a diet restricted in energy and rich in legumes leads to a significant decrease in the concentrations of CRP, complement 3 (C3) and the high sensitivity TNF-α (21). In a cross-sectional study conducted on 486 female teachers in Tehran, Iran, it was found that women who had the highest proportion of legume intake had significant and lower serum concentrations of E-selectin, soluble intercellular adhesion molecule-1 and soluble vascular cell adhesion molecule-1 in comparison with the lowest intake proportions. Legume intake was also inversely associated with serum levels of high sensitivity CRP, TNF-α and IL-6 (Interleukin 6) even after controlling for confounding factors and nutrient intake. However, legume consumption had no impacts on serum amyloid A (40).

The Effects of Legumes on Anthropometric Parameters: The findings of studies in the field of legume consumption and anthropometric indicators are not aligned. A study conducted on the data from NHANES 1999-2002 claimed that those who ate more beans had a lower body weight and waist size ($P < 0.05$). They have a 23% lower risk of an increasing waist size and a 22% lower risk of obesity (41). Nevertheless, the results of such experimental studies in the field are not synchronized. In a study, obese and overweight people who were on a low-calorie and rich in legume diet showed a faster weight loss than the control group ($P = 0.024$). However, the waist circumference decrease and body fat percent were similar in both groups (21). Another study suggested that compared with refined wheat flour, the consumption of whole chickpea flour reduces android fat ratio to gynoid fat in hypercholesterolemic and overweight women (35). In a randomized, double-blind, placebo-controlled study conducted on 25 healthy male subjects, individuals were divided into two groups of white bean extract group and placebo group. After 4 weeks of intervention, both groups were compared to the time before entering the study. Significant weight loss and reduction in the waist size were reported as the result. Nevertheless, from this point of view, there seemed to be no significant difference between the two groups. However, after the division of the subjects based on the food carbohydrate, those who had the highest proportion of carbohydrate intake experienced weight loss and a reduction in the waist size far greater than the ones in the placebo group. This was due to the inhibitory action of the enzyme alpha-amylase (42). Another research on the effects of four hypocaloric diets on 30 obese men stated that after the intervention, all the

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patients experienced weight loss especially those who had been on the hypocaloric diet rich in legumes (32). On the contrary, according to another study, the consumption of whole grains and legume powder instead of refined rice lead to no changes in the body weight and the energy intake (37). Another study attempted to design the effects of three types of diets containing legumes in order to achieve the following objectives: 1) the effects of the processing of the beans on the short-term food intake, appetite and glycemic response in which canned beans were compared with home-made beans; 2) the effects of the bean recipe on the short-term food intake, appetite and glycemic response in which canned beans and home-made beans were compared with white bread; 3) the effects of various legumes (peas, lentils, beans and yellow peas) on the short-term food intake, appetite and glycemic response in which four pulses with equal energy were compared to white bread. With respect to the same topic, the results of a research conducted on 15 healthy men aged 18-35 indicated that all three diets reduced appetite but in none of these methods, the short-term food intake (120 minutes after ingestion) was reduced and only the recipe influenced the glycemic response. Furthermore, an inverse relationship was found between the glycemic response and appetite to food intake in diet 3. In conclusion, the results of this study could explain the relationship between bean consumption and the reduced risk of obesity and overweight (43) (table 1).

Table 1. Studies examining the effects of non-soy legume consumption on CVD risk factors (7, 21, 23, 24, 28, 29, and 36-39)

Source	Study design	Study's explanation	Result
Finley JW, 2007	Crossover	12 weeks; 40 patients with pre-metabolic syndrome (pre-MS) and 40 patients in the control group; 130 g beans with isocaloric diet and chicken soup per day	Bean consumption: TC significant reduction in the amount of 8% in the control group and 4% in pre-MS; HDL and LDL significant reduction in both groups; no effect on TG, VLDL and glucose
Hartman TJ 2010	Crossover	For 4 weeks, 64 men at high risk of colorectal cancer consumed LGI diet rich in legume (250 gr/d) and healthy diet of Americans (HA) and HGI.	STNFRI and CRP significant reduction in both groups (no significant difference); STNFRII peripheral decrease in legumes period and a significant reduction in HA; significant increase in fasting glucose in both groups; unchanged insulin and C- peptid in both groups
Kabagambe EK 2005	Cohort	2119 patients with a history of MI and 2119 control subjects were followed for 10 years.	1 serving per day of beans caused a 38% reduction in the risk of MI. (Adjusted for smoking, history of diabetes, hypertension, obesity, physical activity, income, alcohol, total energy, saturated fat and trans, PUFA and cholesterol
Pittaway JK 2008	Crossover	45 subjects consumed 728 grams of peas in the desired diet for 12 weeks, and then ate a normal diet for 4 weeks.	Significant reduction in TC and LDL levels, fasting insulin and HOMA-IR in the peas use phase
Bazzano LA 2001	Cohort	9632 subjects participated in NHANES I were followed for 19 years.	4 times a week or more consumption of legumes caused a 22% reduction in the risk of coronary heart disease and 11% reduction in the risk of CVD.
Paparikolaou Y 2008	Cohort	8229 cohort of participants in NHANES 1999-2002	Weight and waist circumference less than non-consumers to beans consumers; bean consumption caused 23% lower risk for increased waist size and 22% lower risk for obesity; lower systolic blood pressure by eating beans
Hermsdorff HH, 2010	Parallel	For 8 weeks, 30 obese subjects were randomly assigned to either hypocaloric diet (control) or hypocaloric and rich in legume (4 serving per week).	Bean diet: increased weight loss, significant reduction in TC, LDL and systolic blood pressure, a more significant reduction in CRP and C3 (complement 3). Reduction percent in CRP was positively associated with a decrease in systolic blood pressure and TC in legume diet.
Zhang Z 2010	Crossover	For 4 weeks, 64 men at high risk of colorectal cancer consumed LGI diet rich in legume (250 gr/d) and healthy diet of Americans (HA) and HGI.	Diet rich in legume: significant further reduction in fasting total cholesterol and LDL; in individuals resistant to insulin: further reduction in HDL and TG; in individuals sensitive to insulin: further reduction in total cholesterol, LDL, TC/HDL and LDL/HDL
Villegas R 2008	Cohort	64,227 healthy, middle-aged Chinese women were followed for 4.6 years.	A significant inverse association between intake quintile of all legumes and three legume subgroups (including peanuts, soybeans and other legumes) with type 2 diabetes

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Discussion

Currently, CVD is the major cause of death in western countries as well as in developing countries which imposes high costs on the economy of these communities (23, 44, and 45). It is expected that in 2030, 40.5% of people would suffer heart diseases in America whereas in 2010, the figure used to be about 36.9% (46). The morbidity and mortality in developing countries over the past decade has been rising in a way that 20-45% of all deaths in these countries are attributed to heart conditions (11). Therefore, the prevention of this disease seems to be of paramount importance. One way to prevent and control is planning a modified diet. Legumes as part of a diet can be effective in maintaining health and treating diseases. Legumes have remarkable nutritional properties like vegetable protein, soluble and insoluble fiber, minerals such as potassium, calcium and magnesium, vitamins and bioactive compounds such as polyphenols and saponins (7, 21, and 23). Glycemic Index (GI), Glycemic Load (GL) and sodium are low in legumes. Thus, they are considered as a low-fat diet (21). Studies suggest that foods with a high glycemic index heighten the risk of obesity, type 2 diabetes and CVD by lowering HDL, increased fasting TG, increased fasting insulin, increased CRP and glucose intolerance (47).

Repeated legume intake as low GI foods can help to lipid homeostasis and thus reduce the risk of CVD. Each percent of reduction in the LDL concentration lowers the deaths from CVD as much as one percent (33). Moreover, high fiber content and the presence of such compounds as phytoestrogens, saponins and oligosaccharides are also important factors in this context (48). People who generally use more legumes receive more total fiber, soluble and insoluble fiber (21, 28 and 28), lower saturated fatty acids and cholesterol (21 and 29), polyunsaturated fatty acids, and more polyunsaturated fatty acids compared to saturated fatty acids (29). To explain legumes' possible mechanisms in improving lipid profiles, the effects of legume fiber could be noted. Having soluble fiber and resistant starch, legumes will be able to reduce the total cholesterol and LDL cholesterol by reducing fat absorption and hepatic cholesterol synthesis. Another point is of products resulting from the fermentation of legume fiber. The propionate production of legume fiber, unlike acetate, is not a substrate for lipogenesis and increased production of propionate inhibits the synthesis of fatty acids (7). In addition, legumes' low GI and GL enhance insulin sensitivity, thereby inhibiting the release of saturated fatty acids from adipose tissue leading to the reduction of the hepatic synthesis of Very Low Density Lipoprotein (VLDL). Thus, it will maintain the low concentrations of total cholesterol and LDL. For another thing, the possible reduction of triglyceride levels in the blood could be a result of more vegetable protein intake (28).

The findings of a study in this regard indicate that more legume intake will not be followed by a further increase in the rate of fermentation. Thus, the fermentation of dietary fiber hypothesis is somewhat exaggerated and many of the beneficial effects of legume consumption is associated with other compounds. Among these bioactive compounds are phenolic compounds (e.g. flavonoids) (7). The saponins in legumes convert to diosgenin by intestinal bacteria which could have positive outcomes like increasing the excretion of cholesterol in bile and decreasing cholesterol absorption (21 and 33).

In the same context, Phytosterols compounds might also reduce the levels of blood lipids. Furthermore, stanols and sterols in legumes have a chemical structure similar to that of the cholesterol and so, the risk of cholesterol uptake by entrocytes cells and the amount of esterified cholesterol in entrocytes is noticeably lowered (28 and 49).

For every ten people in America, there is one person with type 2 diabetes, which is equivalent to 25.8 million in total. The prevalence of diabetes mellitus in America is rising rapidly in a way that by the year 2010, 1.9 million new cases were identified (50). By 2010, approximately 8% of the population in Iran had been diagnosed with diabetes mellitus (51). Therefore, the identifying the dietary or food affecting glucose homeostasis in the body is a primary goal to attain. One of the components in our diet are legumes that are able to affect blood sugar status. For the possible causes of legume hypoglycaemia, low glycemic index can be noted due to its high content of fiber and resistant starch (38, 39). The legumes consumed by humans contain a type of starch which is slowly digested. The legume plant structure is also an important factor in determining the rate of starch digestion in the small intestine (38). In addition, legumes increase dietary fiber content and consequently reduce mixed diet glycemic index (36). In addition to the studies on the foods with a low

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glycemic index, many experiments are working on the foods in which the absorption of carbohydrates occurs through inhibiting the enzymes responsible for digestion. These inhibitors include alpha-amylase and glucosidase. White beans contain alpha-amylase inhibitor. It has been shown that a proprietary product called Phase 2 Carb Controller can reduce postprandial glucose peak (52). On the other hand, polyphenols such as isoflavones and lignans have antioxidant properties which may possibly help reduce the risk of type 2 diabetes.

Legumes also contain polyunsaturated fatty acids that lead to increased insulin sensitivity. Antioxidants, legumes fiber and magnesium also reduce the risk of type 2 diabetes (36). On a different note, high blood pressure is an independent risk CVD risk factor. Approximately 65 million American adults have high blood pressure (1 out of every 3 people). In 2010 in America, 33.9% of the population had high blood pressure. It is anticipated that this rate will be up by 37.3% in 2030 (46). A 12-13 degree drop in the blood pressure leads to a 21% reduction in heart attacks, 37% reduction in strokes and 25% reduction in the rate of deaths from CVD (41). In 2000 in Iran, 22% of men and 24% of women had hypertension (53). It is believed that legumes are able to lower blood pressure potently. For people who consume more beans, nutrient intake profiles such as dietary fiber, potassium, magnesium and protein would be beneficially enhanced.

Although the mechanism of the effect of potassium on blood pressure and risk of stroke is still not fully understood, evidence suggests that potassium may directly affect sodium excretion, suppress the renin-angiotensin system, affect the vasoconstriction and vascular resistance and prevent the formation of free radicals (41). Legumes are low in sodium and a prolific source of other minerals such as calcium, copper, iron, magnesium, phosphorus, potassium and zinc which may be effective in reducing blood pressure (21, 41). Recent studies suggest that systemic inflammation is involved in the pathogenesis of atherosclerosis, CHD, diabetes, obesity and metabolic syndrome (10, 54). The levels of inflammatory markers are associated with high blood pressure, low HDL levels and dyslipidemia. Many factors influencing inflammation remain unknown. However, a number of environmental and genetic factors have been identified so far (54). Diet is one of the environmental factors that can influence the levels of inflammatory markers. It is presumed that the fiber content of legumes is able to reduce the CRP concentration. Legume fiber reduces the CRP concentration by slowing down the absorption of glucose and modulating the anti-inflammatory cytokines. Moreover, the high magnesium intake from legumes can reduce CRP levels. With modified microvascular function, stimulating the endothelial growth and inhibiting nitric oxide synthesis and some inflammatory markers, magnesium can ultimately reduce CRP levels (21). In addition, it should be considered that the people who consume more legumes usually have a higher quality diet. Thus, other diet factors such as vitamin C can also be effective in reducing the levels of inflammatory factors (39). It is also noteworthy that legumes also contain antioxidants such as vitamins, rare minerals and other non-nutrients such as phenolic acids, lignans and phytoestrogens which also possess anti-inflammatory properties (37). In today's world, obesity is a serious health problem. In 2005, WHO reported that about 1.6 billion people worldwide are overweight and at least 400 million are obese. It is expected that this figure will be as high as 2.3 billion of overweight and 700 million of obese people in 2015. Currently in Iran, 67% of women and 29% of men are overweight or obese (55). Diet control and physical activity are the key to weight loss (52). Despite the content of carbohydrate, fat and protein, legumes may be effective in body weight regulation through satiety and decrease in food intakes. As far as the related studies go, protein has stronger satiety properties than carbohydrates and fat. As a result, legumes, having high protein and fiber content and low glycemic index, play a major role in the feeling of fullness and ultimately weight loss (48 and 56).

In addition, consuming low GI legumes leads to an increased mitochondrial oxidation compared with a high glycemic index diet that can also be effective in weight loss (21). It is also expressed that the soluble and insoluble fiber found in legumes help reduce body weight. By diminishing the feeling of hunger and energy intake through creating a viscous gel, soluble fibers slow down the gastric emptying as well as the digestion of nutrients. Insoluble fibers also contribute to body weight loss by increasing satiety and energy intake reduction (41). A study in this regard suggests that only 40% of the beans fiber is fermented, which ultimately reduces the high-fiber foods energy content

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per weight unit; i.e. the energy density (57). Finally, Phase 2 Carb Controller in white beans can help reduce body weight 500-3000 mg per day (52). Additionally, recent studies presume that diets with high levels of legumes such as Dietary Approaches to Stop Hypertension (DASH) can have beneficial impacts on metabolic parameters (58,59).

Conclusion

Legume consumption improves lipid profiles. It also has potentially positive effects on reducing blood sugar levels, blood pressure, inflammatory condition and anthropometric parameters. It seems that the impact of legumes on the lipid profile is far greater than in other risk factors although the effect of legumes on other risk factors is also important and requires further study. In the light of the points made above, it seems that consuming legumes reduces CVD risk factors to a great extent. It is essential that further studies be conducted in this field in order to overcome certain limitations of the previous studies. For instance, small sample size, the number of records, insufficient food records or the lack of adequate study done on nutrient intake over several years resulting in a reduced ability to generalize the results and self-reporting of the disease resulting in the adverse classification of the subjects (1, 22, and 25). As for the time being, most studies have come to support the many positive impacts legumes have on reducing a variety of risk factors.

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