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Legume - an inconspicuous fighter against the metabolic syndrome

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Abstract:

Metabolic syndrome (MetS) is metabolic alterations characterised by dysglycemia, raised blood pressure, elevated triglyceride levels, low high-density lipoprotein cholesterol levels, and obesity. It is associated with high morbidity and mortality and the prevalence of it has been increasing in recent years. A significant impact on the risk to develop MetS has dietary habits. Many studies emphasise legume consumption advantages contributing to a decrease of a cluster of metabolic risk factors. The most effective range daily legume consumption is between 55 and 70 g/day.
Some varieties of legumes can reform blood pressure by ACE inhibitory activity. Soybean protein hydrolysis showed an advantageous effect on lipid profile by HMGCR inhibitory activity. Legume intake seems to be a valuable predictor of decreasing BMI and abdominal adiposity because of high fibre levels and regulation of adiponectin and 8-epi-PGF2α in obese subjects. Increasing part of legumes as a protein and carbohydrates source in diet, significantly reduces the risk of glucose-insulin homeostasis disorders.
Evidently, legumes have comprehensive dietary advantages. However more data and further research on the long-term effects of legumes on metabolic alterations are required to elucidate their effective health implications. Present review is based on articles accessible on pubmed service.

Keywords: legume; metabolic syndrome; hypertension; dyslipidemia; obesity

Introduction and purpose:

Metabolic syndrome is one of the most common terms used in the medical world in recent years. It is associated with diseases of affluence like cardiovascular diseases, type 2 diabetes mellitus which have high prevalence and are the major cause of mortality in developed and also underdeveloped countries, furthermore they are related with huge economic burden imposed on the health system. [1,2]

Conceptual definition of metabolic syndrome including five factors: dysglycemia, raised blood pressure, elevated triglyceride levels, low high-density lipoprotein cholesterol levels, and obesity (particularly central adiposity), according to the consensual definition of the International Diabetes Federation, the American Heart Association, and the National Heart, Lung and Blood Institute. [2,3]
This clinical condition may be diagnosed if at last three of the mentioned metabolic components simultaneously occur. [3,4]

MEASURE	DIAGNOSTIC CUT POINTS	ALTERNATE INDICATIONS
Waist circumference	White Canadians, Americans, or Europeans: 94 cm (men), 80 cm (women) People from Asia, Africa, or the Middle East, or indigenous people from North and South America: 90 cm (men), 80 cm (women)	White patients (higher risk): 102 cm (men), 88 cm (women) Health Canada guideline
Triglycerides	≥1.7 mmol/L (150 mg/dL)	Drug treatment of high triglyceride levels
HDL-cholesterol	Men: <1.0 mmol/L (40 mg/dL) Women: <1.3 mmol/L (50 mg/dL)	Drug treatment of low HDL levels
Blood pressure	Systolic ≥130 mm Hg or diastolic ≥85 mm Hg	Drug treatment of hypertension
Elevated fasting glucose	≥5.6 mmol/L (100 mg/dL)	Drug treatment of elevated glucose

HDL—high-density lipoprotein.
Data from Alberti et al.[17]

Harmonised criteria for metabolic syndrome diagnosis: 3 of 5 positive measures are necessary for diagnosis.
origin: https://tinyurl.com/5n97k228

There is evidenced association between the incidence and prevention of metabolic syndrome and modifiable lifestyle factors, particularly dietary habits. [2, 5, 6, 7]
Plant-based diet with a high frequency of legume consumption is an important dietary pattern that undoubtedly contributes to a decrease of a cluster of metabolic risk factors.
The benefits of their consumption are due to the relatively low energy density of legumes and their high nutritional value. Furthermore legumes are an abundant source of many biologically active compounds, such as vitamins, minerals and phenolic compounds which together present preventive activities against many of the abovementioned disorders. [8, 9, 10]

Unfortunately general legume consumption is low. A study examining frequency of legume consumption among surveyed adults from Poland, described that only 22,8 % of all participants frequent consume legumes and the average consumption amount was approximately 21 g/capita per day in all respondents, and approximately 16 g/capita per day in the non-vegetarian respondents. Moreover, ‘rare legume consumers’ declared approximately 7 g/capita per day. [11]

The aim of the present review was to analyse the potential benefits of consuming legumes seeds as an efficient strategy to prevent metabolic syndrome and its comorbidities.

Description of state of knowledge:

Raised blood pressure

Hypertension is a significant and preventable cardiovascular disease risk factor. Blood pressure is mainly regulated by the renin–angiotensin system. Renin converts angiotensinogen to angiotensin I that could be activated by conversion to angiotensin II by angiotensin-converting enzyme (ACE). Angiotensin II is a potent vasoconstrictor and rapidly increases blood pressure. ACE inhibitors are considered as one of the most effective drugs to treat hypertension [12, 13]
Some varieties of legumes have shown ACE inhibitory activity. The effect of fermentation and in vitro digestion on antihypertensive activity of soybean and pea peptides has been evaluated, considering as key processes to release potential ACE inhibitory peptides.

Varieties of legumes have shown ACE inhibitory activity: soybean hydrolysates, small red beans, fermented pea flour, mung bean. [12, 13, 14]

A Norfolk Cohort study, examining Association between Legume Consumption and Risk of Hypertension, described a significant temporal association between higher consumption of legumes and reduced subsequent odds of hypertension over a median 3.7 years of follow up. The most effective range was observed with daily consumption between 55 and 70 g/day, therefore they recommend promotion of legume consumption, in the range which is approximately a cup serving per day. [15]

Dyslipidemia [elevated triglyceride levels and low high-density lipoprotein cholesterol level]

Cholesterol levels depend on absorption and endogenous synthesis.
In endogenous biosynthesis pathway, the 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMGCR) plays a key role and in vitro HMGCR inhibitory activity is frequently tested for potential hypocholesterolemic activity . This kind of activity was noticed in three peptides derived from soybean protein hydrolysis (IAVPGEVA, IAVPTGVA and LPY) .[12, 16]

Studies in rats have shown that some soybean globulins fractions are able to reduce total cholesterol, LDL-cholesterol and triglycerides in the plasma and liver of hypercholesterolemic rats by oral administration. Besides, it was observed decrease in plasma lipids and upregulated liver β-VLDL receptors in hypercholesterolemic rats after isolation of the α' subunit of one of those proteins.
Moreover, soybean protein hydrolysis also generated a pentapeptide that displayed in vitro ability to reduce cholesterol content in micelles and, consequently, decrease cholesterol absorption [12].

Obesity, body weight and central adiposity

A report on the state of obesity pandemic Europe released in 2022 by WHO, stating that 59% of adult citizens and almost 1 in 3 children in the area of Europe are suffering from overweight or obesity. [17, 18]
Research indicates that regular legume consumption may help prevent obesity. They include only small amounts of fat, large amounts of dietary fibre, low glycemic index and also contain high levels of plant protein. All of those factors cause legume seeds are satiating, and they can enhance the gut microbiome. Consequently, miscellaneous legumes have many qualities that may help in the fight against weight gain and its consequences. [19]

A study, which focused on 10-year weight change in connection with legume intake, showed presence of dependence between including legumes into adults diet and their significantly less weight gain than their counterparts and lower BMIs and leaner waists.
Specifically, percent weight gain was 23.5% greater in the non-consumers compared to the moderate/high consumers.
Should be mentioned that when dietary fibre intake was controlled with the other covariates, the association between legume consumption and percent weight change and abdominal adiposity was nullified.[19]
The National Leading Research Laboratory of Clinical Nutrigenetics/Nutrigenomics at Yonsei University performed randomised controlled trial: a 12-week nutritional intervention to determine whether a diet enriched in legumes was associated with weight loss via the regulation of adiponectin and 8-epi-PGF2α in obese subjects. Antioxidant-mediated regulation of adiponectin by transcription factors such as PPAR-γ and sterol regulator element-binding protein was considered as a potential mechanism for the beneficial effect of legume intake on body weight control because they are rich in nutrients that have antioxidant effects. The relationship between the reduction of oxidative stress and weight loss has been clarified in several studies.
A reliable indicator of oxidative stress is 8-Epi-PGF2α because it is a secondary end product of peroxidation, and it is excreted in a stable form in urine. Increased urinary level of 8-epi-PGF2α was observed in subjects with a high oxidation states or abnormal glycaemic control. [20, 21, 22]
The results of that research show that the mean weight loss at 12 weeks was 2,87kg in the legume-enriched diet group and 0,17 kg in the usual diet group, which was significantly different between the groups.
Moreover it was noticed increased levels of HDL-cholesterol and adiponectin, and decreased levels of glucose, insulin, TAG, and 8-epi-PGF2α and insulin resistance index value at 12 weeks compared with baseline in the legume-enriched diet. [20]

Dysglycemia

Legumes are a low glycaemic index food, effective at reducing the postprandial glucose and insulin response compared to that of other carbohydrate-containing foods, such as rice or potatoes. [23]

Several studies observed a statistically significant improved effect on fasting blood glucose, fasting blood insulin, reduction in HbA1c after the legume-enriched diet intervention. However, the evidence base was

considered to be very low quality and there is the need for further high-quality longer term randomised controlled trials to be conducted.[23, 24, 25]

Research from prospective assessment from the PREDIMED study supports an increased consumption of legumes for type 2 diabetes prevention. It pointed to 33% lower risk of developing type 2 diabetes in connection with consumption of legumes, especially lentils.
Substituting half a serving of eggs with legumes in rich in protein food was associated with a 50% lower risk of type 2 diabetes. However, a similar significant link was not observed when fish or meat in high-protein meals were replaced with legumes.
Large benefits were noted when intaking legumes as a source of carbohydrates instead of wholemeal bread, white bread, rice and baked potato, it was associated with a lower risk of type 2 diabetes by about 44-52%. [26]

Summary:

Adopting lifestyle changes, including a healthy diet, are integral to metabolic disorders management and prevention. Growing evidence suggests legumes have beneficial effect on metabolic syndrome components.
In conclusion, some varieties of legumes can reform blood pressure by ACE inhibitory activity.
Soybean protein hydrolysis showed an advantageous effect on lipid profile by HMGCR inhibitory activity.
Legume intake seems to be a valuable predictor of decreasing BMI and abdominal adiposity because of high fibre levels and regulation of adiponectin and 8-epi-PGF2α in obese subjects.
Increasing part of legumes as a protein and carbohydrates source in diet, significantly reduces the risk of glucose metabolism disorder.
The most effective range of daily legume consumption is between 55 and 70 g/day, which is approximately a cup serving per day.

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