Dairy Products Benefits in Lowering Blood Pressure

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ABSTRACT

Hypertension is one of the risk factor leading to cardiovascular disease. Diet plays an important role for preventing hypertension and maintaining blood pressure. One of the dietary approaches includes intake of daily consumption of low fat dairy product. This review will discuss the relationship between daily dairy intake and blood pressure.

Keywords: Blood pressure, dairy, hypertension, milk

ABSTRAK

Hipertensi merupakan salah satu faktor risiko penyakit kardiovaskular. Selain terapi medikamentosa, nutrisi berperan penting dalam mencegah hipertensi dan menjaga tekanan darah. Salah satu pendekatan nutrisi pada pasien hipertensi mencakup konsumsi produk susu rendah lemak. Ulasan ini membahas hubungan konsumsi produk susu dengan tekanan darah. **Michelle Martina, Daniela Angeline. Manfaat Produk Susu untuk Menurunkan Tekanan Darah**

Kata kunci: Hipertensi, produk susu, susu, tekanan darah

BACKGROUND

Diet is one of the essential factors for preventing and treating hypertension.[1] Formerly, people with high blood pressure are traditionally recommended to eat low-salt diet, but as research began to advance, holistic dietary pattern such as Dietary Approaches to Stop Hypertension (DASH) has become one of the dietary guideline for people with hypertension.[1] There are several recommendations in the DASH diet pattern which include reduced saturated fat, total fat, cholesterol, and sugar-sweetened beverages as well as providing abundant serving of fruits and vegetables and grains, including low fat dairy 2-4 servings/day.[1]

Dairy products are food derived from or containing milk such as milk, yogurt, and cheese. Dairy product has been part of healthy eating lifestyle all over the world.[2] Dairy products are rich in micronutrients such as calcium, potassium, and magnesium. They are also rich in protein (casein and whey), and vitamins (riboflavin and vitamin B-12) which are beneficial to cardiovascular health such as stabilizing blood pressure.[3] Conversely, they also contain fat which increases the risk of cardiovascular disease.[4] However, these findings are still inconsistent.[5] Several studies show that milk as one of the mostly consumed dairy source in the society has positive effects in modulating different factors associated to hypertension.[5–7] This paper will review dairy products and their mechanism in lowering blood pressure.

MILK COMPOSITION

The term "milk" is associated with cow milk as 85% milk worldwide was from cows.[2] Buffalo, goat and sheep milk can also be consumed by human. Different animals will produce different kind of milk, and several other factors can also influence the composition of milk, such as the animal feed and lactation stage.[2]

The main composition of milk is water with an average of 68-91% in different kind of milk from different kind of species. The main carbohydrate found in cow milk is lactosewith concentration of 4.5-5.1 gram per 100 gram of milk and it also contains protein ranging 3.2–3.4 gram per 100 grams of milk and fat approximately ranging from 3.1-3.3 gram per 100 gram of milk.[2] Other micronutrients found in milk are calcium, iron, magnesium, potassium, sodium, zinc, copper, selenium, and manganese.[2] It also contains vitamins such as, vitamin E, thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, folate, biotin, vitamin B12, vitamin C, and vitamin D.[2] Milk compositions that play significant role in decreasing blood pressure are milk peptides, calcium and vitamin D, potassium, phosphorous, and magnesium.[1,6]

The role of milk is primarily to nourish the infants of a species. Milk is a complex food containing numerous nutrients. Most constituents in milk do not work in isolation, but rather interact with other constituents.[2] Dairy can be an important part of healthy and balanced diet. However, as technology began to evolve, different kind of dairy products with differing compositions began to emerge; consumer should be aware of the product's nutritional profile and its contribution to the diet.[2]

DAIRY COMPOSITION AND THEIR MECHANISMS ON BLOOD PRESSURE

Dairy products contain proteins that during food processing or in the intestinal tract were broken down to peptides. The break down

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mechanisms includes fermentation process by bacteria and yeasts, hydrolysis by enzymes, and also by gastrointestinal enzymes. The mechanism of lowering blood pressure come from the interaction of the milk peptides and the electrolytes present in dairy products, most notably calcium, potassium, phosphorus, and magnesium.[6] Angiotensin Converting Enzyme (ACE) inhibition by milk peptides was proven as one of the most influential factor.[7] The other factor includes the electrolytes composition that are proven to have effect on lowering smooth muscle contraction and cause vasodilatation.[7]

Milk Peptides

Bovine milk including cow's milk contains protein, consists ofcasein (80%) and whey protein (20%).[5] When milk proteins are broken down by digestive enzymes or by the proteinases formed by lactobacilli during fermentation of milk, biologically active peptide fragments are formed. Bioactive peptides are specific protein fragments that have been shown to influence physiological functions, ultimately, and health.[6,8] Evidence also suggest that this bioactive peptide plays important role in lowering blood pressure.[7] The effects of milk-derived proteins and peptides in lowering blood pressure are mediated through the inhibition of ACE or via non-ACE-inhibition routes.[5]

Renin-angiotensin-aldosterone system (RAAS) is a significant regulator of blood pressure in human.[8] In this system, angiotensin I is converted to angiotensin II by ACE. Angiotensin II will cause vasoconstriction and induce the release of aldosterone which will cause sodium retention and therefore increase blood volume and causes increase in blood pressure.[8] This effect of angiotensin II and aldosterone can be inhibited by ACE-inhibitor drugs such as captopril, resulting in vasodilatation.[9] Milk peptides acts as an ACE inhibitor and it can also inhibit degradation of vasodilator compounds.[5,6] Other mechanisms other than ACE-inhibitor routes are the immunomodulatory pathways and inhibition of the sympathetic nervous system through opioid-like activity from these peptide fragments. Opioid acts as regulator of the circulation, it affects blood pressure by significantly decrease sympathetic activity after consumption of milk.[5] This opioid-like activity has been discovered in many peptides derived from casein such as a- and b-casomorphins.[5]

Calcium and Vitamin D

Milk provides approximately 91–120 mg calcium per 100 grams.[2] Calcium is a potent mediator of cellular response, it works as key in the regulation of smooth muscle function, peripheral vascular tone, blood pressure, and volume homeostasis. Parathormone plays an important role since it regulates the calcium-influx to the cells and increases the vasoconstrictive effect. Dietary calcium up to >1000 mg per day will give positive effect to the intracellular ion levels, via the suppression of parathormone and therefore reducing the blood pressure.[10] However, a Cochrane systematic review of calcium supplementation found that causal association between calcium supplementation and blood pressure reduction was weak, due to poor quality trials and heterogeneity among trials.[6]

The main source of vitamin D is human skin exposure to sunlight.[11] Ultraviolet-B from the sun prompts the development of pre-vitamin D3 from 7-hydrocholesterol in the skin, which then undergoes thermal isomerization to form vitamin D3. It later undergoes hydroxylation to form 25-hydroxyvitamin D (25(OH)D) in the liver and subsequently gets converted to 1,25-dihydroxyvitamin D3 (1,25 (OH2)D3) in the kidneys, blood vessels, and heart.[12] People who work in indoor spaces and shift workers are at risk to suffer from vitamin D deficiency.[11] Other main source of vitamin D besides sunlight is from food, such as fortified milk; other form of milk product such as cheese, yogurt, and ice cream are not commonly fortified. Low vitamin D level decrease the calcium resorption from the small intestine, renal, and bone and will signal the parathormone and lead to vasoconstrictive effect. Vitamin D also deactivates RAAS which can decrease the renin stimulation of angiotensin II and aldosterone production, thus decreases blood pressure by preventing vasoconstriction and also preventing sodium and water retention.[6]

Potassium

Milk provides approximately 132–155 mg potassium per 100 grams.[2] Potassium is an essential nutrient needed to maintain total body fluid volume, acid and electrolyte balance, and normal cell function.[13] In the diets of our human ancestors, potassium intake was very high, but in modern society it has been reduced drastically due to food processing and diet low in fresh fruits and vegetables.[13] Potassium has an opposing effect to sodium on arterial vasodilatation. Potassium mechanism in decreasing blood pressure is associated with vasodilatation via stimulation of Na-K ATPase and the opening of potassium channels of the NA-K ATPase, therefore will decrease vascular smooth muscle contraction by altering membrane potential or restoring endothelium-dependent vasodilatation.[6] The recommendation of potassium intake in hypertensive patient is 4.7 gram per day; a glass of milk can provide up to 350 mg of potassium, but patient with chronic kidney disease, diabetes, and congestive heart failure with impaired excretion will have to consume lower potassium intake.[1,6] However, the evidence on the potential beneficial effect of increased potassium intake on blood pressure and cardiovascular disease is not consistent.[14]

Phosphorus

Phosphorous, another mineral abundant in milk, is approximately 84-95 mg per 100 gram.[2] Phosphorus has critical role in cellular structure and function, thus may have attributed to blood pressure regulation through its role in plasma membrane structure.[15] Phosphorus is also involved in calcium regulation; this may lead to the blood pressure lowering effect in high phosphorus diet. Study shows that dietary phosphorus was inversely associated with blood pressure in *in vitro* and also in human trial, although findings are still limited.[16] In another study it was shown that phosphorus from dairy products but not from other sources was associated with lower baseline of blood pressure and reduced risk of hypertension incident. This finding indicates that there might be a synergic effect of phosphorus when combined with other dairy constituents.[15]

Magnesium

Milk consists approximately 10-11 mg of magnesium per 100 gram.[2] Magnesium plays an important role in calcium transport and the regulation of vascular tone and endothelial function by inhibition of vascular smooth muscle contraction, causing vasodilatation; it acts like calcium channel blocker.[16] As well as phosphorus, magnesium is more effective in reducing blood pressure when

administered in natural form as a combination of magnesium, potassium, and calcium than given alone.[14]

Low Fat vs. Non-Low Fat Milk

Study by Drouin-Chartier, *et al*,[17] showed that daily servings of dairy products have beneficial effects on daytime systolic ambulatory blood pressure in men with mild to moderate essential hypertension, but no effect on women. Contradictory to this result, DASH study showed that the DASH diet compared with the fruits and vegetables diet significantly reduced blood pressure in women, but not in men.[17,18] DASH studyincluded bigger number of participants than study by Drouin-Chartier, *et al*.[18]

A study by Babio, *et al*,[19] try to differentiate the impact of different type of dairy products, showed that the consumption of low fat dairy products, yoghurt, and lowfat milk is associated with a lower incidence of metabolic syndrome, including high blood pressure and other clinical criterias. Whereas, increased total intake of cheese was associated with higher risk of developing high blood pressure.[19] This result shows a direct association between the consumption of cheese and incident of metabolic syndrome. However, this effect is discordant with the result of the prospective CARDIA (Coronary Artery Risk Development in Young Adults) study, which showed an inverse association between the consumption of whole fat dairy products and cheese towards metabolic syndrome in adults over 18 years.[20] The age of the participants in Babio, *et al*, are generally older and have higher risk in cerebrovascular disease (CVD) than participants in CARDIA study.[19,20]

The CARDIA study shows that increased dairy intake have strong inverse association with metabolic syndrome among overweight adults and may reduce risk of developing cardiovascular disease, including towards elevated blood pressure.[20] These associations were not confounded by other lifestyle factors or dietary variables that are correlated with dairy intake and did not differ by race or sex, as this study also exclude participants with existing metabolic syndrome at the baseline.[20] The hypothesis suggested in CARDIA, other than the mechanism of calcium, potassium, and magnesium towards blood pressure is that protein and fat in dairy products may induce satiety and reduce the risk of overweight related to other food which contain high carbohydrate.[20] But another study did not find any relationship between dairy intake and blood pressure among people with normal body mass index (BMI).[20] A study by Louie, *et al*,[21] show no association between total dairy consumption and risk of metabolic syndrome nor type 2 diabetes.

RECOMMENDATION

The effect of dietary changes in hypertensive patient is likely achieved from several aspects of the diet, rather than just one nutrient or food. European Society of Cardiology (ESC) and the European Society of Hypertension (ESH) suggest increasing consumption of vegetables, fresh fruits, fish, nuts, and unsaturated fatty acids; low consumption of red meat and consumption of low-fat dairy products are recommended.[9] American Heart Association (AHA) recommend DASH diet which emphasizes fruits and vegetables (5-9 servings per day) and low-fat dairy products (2-4 servings per day) to obtain diet rich in potassium, magnesium, and calcium.[22] DASH diet significantly lowered mean systolic by 5.5 mmHg and mean diastolic by 3.0 mmHg;[23] the lowering effects were more distinct in hypertensive and black patient rather than in normotensive patient.[14,23] Diet emphasized on fruits and vegetables is also proven to lower blood pressure but to a lesser extent, about half of the effect of the DASH diet.[23]

CONCLUSION

Dairy product is beneficial in people with hypertension especially those vulnerable to cardiovascular disease. Some studies show that low fat dairy product lower blood pressure, while whole fat dairy product such as cheese has inverse association towards blood pressure. Consumption of up to 2-4 servings/day of low fat dairy product is recommended for people with hypertension according to DASH diet. Further studies are warranted to search the effect of different type of dairy products and the specific effect of dairy products towards blood pressure and other comorbidities to provide more specific recommendation on the consumption and type of dairy product.

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