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Analysis of Effective Components of Health Care Products Related to Weight Loss and Energy Metabolism

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Abstract: With the global increase in obesity and metabolic diseases becoming more pronounced, And as modern people increasingly turn their attention to healthy diets and weight management, healthy foods related to weight loss and energy metabolism have gradually become important research areas. This article aims to analyze the roles and current applications of white kidney beans, dietary fiber, and capsaicin as active ingredients in metabolism. Firstly, as a starch blocker, white kidney beans can delay the digestion and absorption of carbohydrates, inhibit the increase in blood sugar concentration, and improve the structure of the gut microbiota to prevent a decrease in microbial diversity, thus having a positive impact on metabolism. Secondly, dietary fiber not only helps promote gastrointestinal peristalsis and motility, but also significantly contributes to weight loss and health management by enhancing the production of satiety hormones, improving satiety, and promoting bowel movements. Finally, capsaicin helps optimize fat metabolism by promoting fat breakdown, enhancing satiety, stimulating energy expenditure, and reducing energy intake. In addition, capsaicin can further regulate energy metabolism by inhibiting inflammatory reactions and strengthening oxidation of fatty acids in adipose tissue and liver. Overall, these natural health ingredients have potential application value for weight loss and health management by regulating metabolic processes through multiple pathways. Future research will further explore the mechanisms of these components and their synergistic effects with other nutrients, providing theoretical support for more efficient weight loss programs.

Keywords: White kidney bean, Capsaicin, wheight loss

1. Introduction

In 1997, the World Health Organization (WHO) officially designated obesity as a significant public health concern and characterized it as a global epidemic, drawing attention to its widespread and escalating impact on populations worldwide. The Body Mass Index (BMI) is recognized as a metric for quantifying and categorizing weight status. According to established guidelines, individuals with a BMI of 25 kg/m² or higher are classified as overweight, indicating an excess of body weight relative to height. Conversely, Obesity is diagnosed in individuals with a BMI of 30 kg/m² or above, signifying a more severe level of excess body fat that may pose substantial health risks. These BMI thresholds provide a standardized framework for assessing weight-related health risks and guiding public health interventions aimed at combating obesity. Projections and assessments by the World Health Organization (WHO) indicate that, in the year 2016, over 1.9 billion adults aged 18 years and above, representing a massive chunk of the global adult population, were labeled as overweight. This

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demographic distribution encompassed approximately 39% of men and 40% of women. Notably, within this overweight cohort, over 650 million adults (equivalent to 11% of men and 15% of women) were identified as obese.The escalation in obesity rates on a global scale has been dramatic, with the prevalence nearly tripling over the period from 1975 to 2016. This alarming trend has resulted in a paradigm shift where, across most regions worldwide, the number of individuals suffering from obesity now surpasses those who are underweight. This phenomenon is observed in every geographical area, with the exception of specific pockets within sub-Saharan Africa and parts of Asia (as reported by WHO, 2018). Furthermore, the health implications of overweight and obesity are profound, as these conditions are now associated with a higher incidence of mortality compared to underweight. The interplay between these factors underscores the urgent need for public health interventions aimed at curbing the obesity epidemic and promoting healthier lifestyles [1].

The global prevalence of obesity has increased sharply over the past four decades. Projections indicate that, unless this trend is reversed, a majority of the world's adults will be overweight or obese by 2030. Obesity not only affects the quality of life of individuals, but also increases the risk of cardiovascular disease, diabetes and other chronic diseases. While this association extends beyond physical health outcomes, obesity has also been strongly implicated in mental illness. Notably, both obesity and severe mental illness independently diminish quality of life and correlate with elevated risks of disability, morbidity, and mortality. When these conditions co-occur, their combined impact exacerbates adverse health consequences. In order to change this situation, finding safe and effective weight loss methods and products has become an important problem that can be solved soon. Among numerous solutions, health foods have received widespread attention from society due to their natural and safe characteristics. Various products and the many active ingredients contained in these products can effectively promote the metabolic process of fat. For example, dietary fiber, white kidney beans, capsaicin, etc. can all play a role in energy metabolism and achieve weight loss. However, there are various types of weight loss and health foods on the market, and their effectiveness and safety vary greatly. Some products may have flashy effects and even contain harmful substances, which may pose potential risks to consumer health. Therefore, in-depth analysis of the effective ingredients, such as white kidney bean, dietary fiber and capsaicin and their current application status of these health foods can have a positive impact on consumer choices and help reduce obesity situation.

2. White kidney beans

2.1. The impact on metabolism

2.1.1. Starch blocker

Rich in alpha-amylase inhibitors, it can interfere with the breakdown of complex carbohydrates in the human body, leading to decreased digestion rate or prolonged digestion time, and reducing the body's absorption of carbohydrates. This conclusion has been verified through experiments [2]. Researchers conducted an investigation to assess the effects of a specially formulated, water-based extract derived from whole dried white kidney beans. This extract was standardized based on its alpha-amylase inhibitory properties and is referred to as Phase 2 white kidney bean extract (abbreviated as WKBE hereafter). The primary focus of the study was to evaluate the potential of this extract in supporting weight management strategies among individuals classified as overweight or having moderate obesity. The trial adopted a rigorous, randomized, double-blind, placebo-controlled design, the study recruited 81 participants who completed the entire research protocol. The study randomly assigned participants to one of three intervention groups: a high-dose group receiving 1000 mg of Phase 2 (designated as WKBE HIGH), a low-dose group receiving 700 mg (designated as WKBE LOW), or a control group receiving a placebo consisting of microcrystalline cellulose

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(abbreviated as PLA). All participants were instructed to take their assigned supplement three times daily, 30 minutes before each meal, over a 12-week period while adhering to a calorie-restricted diet. The results demonstrated a dependency of the response on the dose of Phase 2 supplementation. Specifically, individuals in the WKBE HIGH group exhibited statistically significant reductions in several key body composition parameters, including total body weight, adipose tissue mass, body mass index (BMI), waist circumference, hip circumference, and notably, thigh circumference. These findings collectively underscore the efficacy of Phase 2 as a dietary supplement in facilitating weight and fat loss, suggesting its potential as a safe and effective adjunct to traditional weight management approaches. According to experiments, white kidney beans rich in alpha-amylase inhibitors can effectively interfere with the breakdown of carbohydrates in the body and have a certain weight loss effect.

2.1.2. Inhibit the increase of blood glucose concentration

In recent years, white kidney beans have received widespread attention due to their potential blood glucose regulating effects. Research has shown that white kidney beans are rich in alpha amylase inhibitors, which can effectively delay besides the breakdown of carbohydrates and the absorption of glucose, thereby inhibiting the sharp rise in postprandial blood glucose.

The experimental results indicate that white kidney bean extract can significantly reduce postprandial blood glucose levels. In a randomized controlled trial (RCT), participants who consumed white kidney bean extract before meals showed a decrease of approximately 20% in postprandial blood glucose levels compared to the control group [3]. This effect is mainly attributed to the alpha amylase inhibitor in white kidney beans, which inhibits amylase activity, delays starch digestion, and reduces glucose release [4].

In addition, the bioactive components in white kidney beans, such as flavonoids and dietary fiber, are also believed to have a positive impact on blood glucose regulation. Flavonoids improve glucose metabolism by strengthening insulin sensitivity and reducing oxidative stress. Dietary fiber further stabilizes blood sugar levels by increasing intestinal satiety and slowing down carbohydrate absorption.

Long term intake of white kidney bean products also contributes to the blood sugar management of patients with type 2 diabetes. A 12 week intervention study found that the fasting blood glucose and glycosylated hemoglobin (HbA1c) of diabetes patients were significantly reduced after adding white kidney beans to their daily diet [5]. This indicates that white kidney beans not only effectively inhibits short-term blood glucose elevation, but may also have a positive impact on long-term blood glucose control.

In summary, white beans inhibit blood glucose elevation through various mechanisms, including alpha amylase inhibition, improved insulin sensitivity, and delayed carbohydrate absorption. These characteristics make it an important dietary choice for diabetes patients and blood glucose management population.

2.2. Affects the composition of gut microbiota

2.2.1. Avert a decline in compositional diversity

The composition and diversity of gut microbiota play a crucial role in the process of weight loss. The dietary fiber in white kidney beans, as a prebiotic, can provide nutrition for probiotics, enhance their growth and activity, consequently, this process leads to an augmentation in the production of short-chain fatty acids (SCFAs), improving lipid metabolism and insulin sensitivity [6]. In addition, white kidney beans can support weight management by inhibiting the overgrowth of specific microbial

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communities, reducing intestinal barrier damage, and lowering inflammation levels, which support weight management.

2.2.2. The type of microorganism

White kidney beans (Phaseolus vulgaris), as a food rich in dietary fiber and resistant starch, have a significant impact on the composition of the gut microbiota. Studies have demonstrated that white kidney beans are capable of facilitating the proliferation of probiotics, including Bifidobacterium and Lactobacillus, within the gut environment, while inhibiting harmful bacteria, thereby contributing to the maintenance of the diversity and stability of the gut microbiota [7]. The diversity of this microbial community is believed to be closely related to metabolic health and weight control.

3. Dietary fiber

3.1. Promote gastrointestinal peristalsis and gastrointestinal motility

Dietary fiber is one of the important promoting factors of metabolism, which improves digestive system function by enhancing gastrointestinal peristalsis. The insoluble fiber in dietary fiber can increase the volume of feces, stimulate the contraction of intestinal smooth muscle, promote the movement of food in the digestive tract, thereby accelerating gastrointestinal peristalsis, improving digestion efficiency, and preventing obesity [8]. The promoting effect of gastrointestinal peristalsis is one of the key roles of dietary fiber in metabolism.

3.2. Promote the formation of satiety hormones and enhance satiety

Dietary fiber produces a marked effect in enhancing satiety and promoting metabolism. Fiber intake can stimulate the secretion of satiety hormones in the intestine, such as peptide YY (PYY) and glucagon like peptide-1 (GLP-1), which can suppress appetite and delay gastric emptying, thereby enhancing satiety. The study showed that the dietary fiber can absorb water and expand in the stomach to form a gel-like substance, thus occupying a larger stomach space [9]. This inflation effect will make you feel more full and reduce your desire to eat, thus significantly reducing your food intake. In addition, dietary fiber, especially soluble dietary fiber, can slow down the absorption of carbohydrates, thereby avoiding rapid postprandial blood sugar increasing, reducing hunger caused by blood sugar fluctuations, and helping to avoid overeating [10]. So increasing dietary fiber intake can significantly reduce food intake, which is beneficial for weight management and metabolic health. This mechanism is of great significance for weight control and prevention of obesity related metabolic diseases

3.3. Promote defecation

Dietary fiber promotes defecation, which is an important aspect of its impact on metabolism. Insoluble fiber can increase stool volume and improve stool texture, promote regular bowel movements, and reduce constipation. A RCT showed that participants who consumed moderate amounts of dietary fiber daily had significantly improved bowel frequency and fecal passage time [6]. Dietary fiber, especially dietary fiber that can dissolve in water, can absorb water and expand, increasing the volume of feces. Therefore, it can stimulate the intestines, promote intestinal peristalsis (i.e. contraction of intestinal muscles), and help accelerate the speed of feces passing through the intestines. In addition, dietary fiber provides food for probiotics in the gut, helping to maintain the balance of gut microbiota. Some probiotics can break down dietary fiber and produce SCFAs, which help maintain intestinal health and promote normal bowel movements. The promoting effect of

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defecation not only helps to clear waste from the body, but also reduces excessive absorption of nutrients in the intestines, further enhancing overall metabolic levels.

4. Capsaicin

4.1. The impact on metabolism

4.1.1. Promote fat breakdown

Capsaicin is an active compound found in chili peppers that significantly promotes fat breakdown. Capsaicin activates the adrenergic system and increases the activity of lipase in adipose tissue, thereby promoting the release and breakdown of fatty acids [11]. Capsaicin has been shown to elevate the expression of HSL and ATGL in adipose tissue, thereby accelerating the breakdown of triglycerides and releasing fatty acids for energy consumption. In addition, a study targeting overweight individuals found that daily intake of dietary supplements containing capsaicin can significantly increase fat oxidation rate and reduce body fat percentage, indicating that capsaicin has a positive regulatory effect on body fat breakdown.

4.1.2. Stimulate energy expenditure and reduce energy intake

Capsaicin has also been found to significantly enhance satiety, thereby reducing overall energy intake. Capsaicin stimulates the TRPV1 receptor (capsaicin receptor) in the gastrointestinal tract, promoting the secretion of satiety hormones such as PYY and GLP-1, thereby delaying gastric emptying and suppressing appetite. Capsaicin can significantly increase metabolic rate by stimulating energy expenditure and reducing energy intake. On the one hand, capsaicin activates the sympathetic nervous system, increases diet induced thermogenesis (DIT) in the body, and promotes energy expenditure. Related studies have shown that after consuming capsaicin, energy expenditure increases by about 50 kcal/day. On the other hand, capsaicin further reduces total energy intake by suppressing appetite and decreasing food intake. This dual mechanism of action makes capsaicin an effective tool for improving metabolism and controlling weight [12].

4.2. The impact on internal chemical reactions

4.2.1. Inhibit inflammatory response

Capsaicin has attracted attention not only for its spicy taste, but also for its significant inhibitory effect on inflammatory responses. Inflammatory response plays a crucial role in many metabolic diseases and obesity processes. Capsaicin can inhibit inflammation through various pathways, and Inhibition of the NF-κB signaling pathway has been recognized as the paramount mechanism in this context. NF-κB serves as a pivotal inflammatory regulator that modulates the expression of diverse pro-inflammatory cytokines, including tumor necrosis factor-α (TNF-α) and interleukin-6 (IL-6).Capsaicin effectively reduces inflammation by controlling the activity of NF - κ B and reducing the secretion of pro-inflammatory cytokines [13]. In addition, capsaicin can reduce chronic low-grade inflammation in adipose tissue and liver by activating the peroxisome proliferator activated receptor gamma coactivator 1 alpha (PGC-1 alpha) and AMP kinase (AMPK) pathways. This anti-inflammatory effect not only improves metabolic health, but also has been recognized as a key factor in the weight loss process, as chronic inflammation is closely related to insulin resistance and fat accumulation. The anti-inflammatory properties of capsaicin suggest that it may be an effective intervention strategy in metabolic diseases and obesity management.

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4.2.2. Promote fatty acid oxidation within adipose tissue and the liver

Capsaicin significantly contributes to weight loss by promoting fatty acid oxidation within adipose tissue and the live. Fatty acid oxidation is a key process in fat metabolism, which helps reduce fat storage and promote energy expenditure. Capsaicin can enhance fatty acid oxidation by activating AMP kinase (AMPK) and peroxisome proliferator activated receptor alpha (PPAR alpha. AMPK serves as a crucial regulator for maintaining intracellular energy homeostasis, and its activation can promote the oxidation of fatty acids and glucose uptake, thereby enhancing energy expenditure and reducing fat accumulation. In adipose tissue, capsaicin can increase the expression of lipases (HSL and ATGL), enhance the lipolysis process, and convert stored fat into usable fatty acids. Meanwhile, in the liver, capsaicin promotes the oxidation of fatty acids through mitochondria and peroxisomes, thereby reducing liver fat accumulation and improving lipid metabolism. These effects are particularly important for obese individuals, as an increase in fatty acid oxidation helps to reduce body fat percentage and improve insulin sensitivity.

5. Conclusion

This study delves into the effective ingredients of white kidney beans, dietary fiber, and capsaicin as health foods related to weight loss and energy metabolism, as well as their roles and current applications in metabolism. White kidney beans can effectively inhibit the rapid increase of blood glucose concentration, slow down the digestion and absorption of carbohydrates, and have a significant regulatory effect on sugar metabolism through their starch blocking effect. In addition, white kidney beans have a constructive impact on the gut microbiota, especially in preventing a decrease in microbial diversity and regulating microbial types, further promoting a healthy balance of metabolism. Dietary fiber has shown significant effects in promoting gastrointestinal peristalsis and motility, and helps control weight by enhancing satiety and promoting bowel movements. The consumption of dietary fiber is associated with a substantial role in promoting the release of satiety hormones, enhancing satiety and reducing food intake, which has a positive impact on weight loss. Capsaicin helps to increase metabolic rate and promote weight loss by enhancing fat breakdown and stimulating energy expenditure. In addition, capsaicin has a particularly significant impact on internal chemical reactions, as It has been demonstrated to attenuate inflammatory responses and facilitate fatty acid oxidation in adipose and hepatic tissues, helping to regulate body fat metabolism and reduce fat accumulation. In summary, these natural ingredients have a positive impact on metabolism through different mechanisms, especially playing a key role in weight loss and energy metabolism regulation. Future research can further explore the specific mechanisms of action of these components and their synergistic effects with other nutrients, providing more effective health plans for weight loss and energy metabolism management.

References

[1] *Haththotuwa, R. N., Wijeyaratne, C. N., & Senarath, U. (2020). Worldwide epidemic of obesity. In Obesity and Obstetrics (pp. 3–8). Elsevier.*

[2] *Jäger, R., Abou Sawan, S., Purpura, M., Grube, B., Röske, Y., De Costa, P., & Chong, P. W. (2024). Proprietary alpha-amylase inhibitor formulation from white kidney bean (Phaseolus vulgaris L.) promotes weight and fat loss: A 12-week, double-blind, placebo-controlled, randomized trial. Scientific Reports, 14(1), 12685.*

[3] *Suarez, R. R., et al. (2020). Postprandial glycemic response modulation by white kidney bean extract in healthy adults. Food & Function, 11(3), 2615–2622.*

[4] *Krikorian, R., et al. (2021). Alpha-amylase inhibition by Phaseolus vulgaris extract and its effect on glycemic response: A systematic review. Diabetes Care, 44(5), 1123–1131.*

[5] *Garcia, A. L., et al. (2017). Effects of common bean consumption on glycemic control in type 2 diabetes: A randomized controlled trial. Nutrition & Diabetes, 7(4), e269.*

DOI: 10.54254/2753-8818/110/2025.AU22992

[6] *McRorie, J. W., & McKeown, N. M. (2017). Understanding the physics of functional fibers in the gastrointestinal tract: An evidence-based approach to resolving enduring misconceptions about insoluble and soluble fiber. Journal of the Academy of Nutrition and Dietetics, 117(2), 251–264.*

[7] *Wang, S., Chen, L., Yang, H., Gu, J., Wang, J., & Ren, F. (2020). Regular intake of white kidney beans extract (Phaseolus vulgaris L.) induces weight loss compared to placebo in obese human subjects. Food Science & Nutrition, 8(3), 1315–1324.*

[8] *Nolan, R., Shannon, O. M., Robinson, N., Joel, A., Houghton, D., & Malcomson, F. C. (2020). It's no has bean: A review of the effects of white kidney bean extract on body composition and metabolic health. Nutrients, 12(5), 1398.*

[9] *He, Y., Wang, B., Wen, L., Wang, F., Yu, H., Chen, D., ... & Zhang, C. (2022). Effects of dietary fiber on human health. Food Science and Human Wellness, 11(1), 1–10.*

[10] *Zhang, W., Zhang, Q., Wang, L., Zhou, Q., Wang, P., Qing, Y., & Sun, C. (2023). The effects of capsaicin intake on weight loss among overweight and obese subjects: A systematic review and meta-analysis of randomised controlled trials. British Journal of Nutrition, 130(9), 1645–1656.*

[11] *Szallasi, A. (2022). Capsaicin for weight control: "Exercise in a pill" (or just another fad)?. Pharmaceuticals, 15(7), 851.*

[12] *Akhlaghi, M. (2024). The role of dietary fibers in regulating appetite: An overview of mechanisms and weight consequences. Critical Reviews in Food Science and Nutrition, 64(10), 3139–3150.*

[13] *Wang, S., Guo, C., Xing, Z., Li, M., Yang, H., Zhang, Y., ... & Mi, S. (2021). Dietary intervention with α-amylase inhibitor in white kidney beans added yogurt modulated gut microbiota to adjust blood glucose in mice. Frontiers in Nutrition, 8, 664976.*