Scholastic Medical Sciences

Research Article

Volume 3 Issue 2- 2025

A Systematic Review (Before 16 October 2024) on the Potential Anti-Hypertensive Effects of Oats and/or Banana

Laura Jia En Lai, Maurice Han Tong Ling

School of Health and Nursing, Management Development Institute of Singapore, Singapore, Department of Life Sciences, University of Roehampton, United Kingdom.

Corresponding Author: Maurice Han Tong Ling, School of Health and Nursing, Management Development Institute of Singapore, Singapore, Department of Life Sciences, University of Roehampton, United Kingdom.

Received: March 10, 2025; **Published:** March 22, 2025

Abstract

With the increasing prevalence of hypertension globally, easily accessible preventive measures are of rising popularity; such as, the addition of oats and bananas into one's diet. However, the effects of oats and banana consumption have not been systematically reviewed. Hence, we conduct a systematic review on the potential anti-hypertensive effects of oats and/or banana using studies indexed in PubMed prior to 16 October 2024. 22 of 171 initial articles included and classified into three main themes: (i) antihypertensive effects of oats, (ii) antihypertensive effects of bananas, and (iii) factors affecting adherence to regular consumption of oats / bananas. We find that oats or bananas do have anti-hypertensive benefits but must be consumed regularly and consistently for an extended period for their benefits. There are no studies examining the potential synergistic anti-hypertensive effects of oats and banana consumption; hence, a potential area for future work.

Keywords: Oats, Banana, Antihypertension

Introduction

According to the National Health and Nutrition Examination Survey, blood pressure control in the United States has been on a decline, from 48.4% in 2015 to 2016, to 43.7% in 2017 to 2018 [1]. Globally, 1.13 billion people have been diagnosed with hypertension, with the worldwide burden predicted to surpass 1.5 billion people by 2025 [2]. Hypertension is classified as the consistent blood pressure at ≥130 / ≥80 mmHg [3]. This growing prevalence of hypertension is worrying as it is a risk factor for much health complications; such as, heart attack, kidney failure, and atherosclerosis.

Modifiable factors that contribute to hypertension include obesity and unhealthy eating habits [4]. Obesity can be defined as having a Body Mass Index of ≥30 kg/m^2; an increase in low-density lipoproteins, also known as bad cholesterol; and a decrease in high-density lipoproteins, which are good cholesterol [5]. Being obese or overweight requires the heart to work harder; thereby, compounding stress on the heart and blood vessels [6]. Unhealthy eating patterns such as the overconsumption of sodium can also cause hypertension [7]. Excess sodium causes the body to retain more water to re-establish osmotic equilibrium. A diet lacking in potassium will exacerbate the problem as potassium helps balance the amount of sodium in your cells [8]. Potassium also allows the blood vessel walls to relax; hence, lowering blood pressure [9]. With the rise in popularity of "functional foods", which are foods with the potential to prevent or manage chronic illness, including hypertension, the consumption of oats and bananas may serve as possible solutions to combat hypertension [10–12].

Oats, known as *Avena Sativa L.*, is an annual grass that contains the highest quality and quantity of protein compared to other cereal grains [13]. Oat bran and whole oats have been consumed for their ability to reduce the risks of cardiovascular diseases and their risk factors, such as diabetes, hyperlipidaemia, and hypertension [11]. Bananas are the fruit of the genus *Musa*, rich in potassium and other important minerals and vitamins, and have been consumed to help the body perform critical functions, as well as improve heart health, digestive health, diabetes management, and hypertension control.

Of the 6 systematic reviews available on PubMed, they either focus on specific components or on specific products [14–19]. Hence, there is a research gap in evaluating the anti-hypertensive effectiveness of consuming oats and bananas as a whole. There is also a lack of studies done on the combined effects of oats and bananas, which may have synergistic anti-hypertensive effects, making it a viable meal option. Therefore, we present a systematic review to examine the anti-hypertensive effects of oat and/or banana.

Methods

A PubMed search was conducted on 18 October 2024, for studies published before October 16, 2024. The search terms "((oat OR oats OR oatmeal) OR (banana AND banana*)) AND (hypertension OR "high blood pressure")" were used URL

https://pubmed.ncbi.nlm.nih.gov/?term=((oat+OR+oats+OR+oatmeal)+OR+(banana+AND+banana*)+AND+(hypertension+OR+%E2%80%9Dhigh+blood+pressure%E2%80%9D)&filter=dates.1000/1/1-2024/10/15

The exclusion criteria were (A) non-English articles; (B) articles with no free full-text access; (C) non-primary articles, including narrative reviews, systematic reviews, and meta-analysis; (D) articles that are unrelated to human health and nutrition; (E) articles that do not study oats or bananas; and (F) articles that do not study hypertension.

Results and Discussion

A total of 172 articles were retrieved from PubMed utilising the detailed search terms (Figure 1). 22 articles were then selected from the articles retrieved, consisting of 2 animal studies, and 20 human studies. The articles were then separated into three main themes (Table 1).

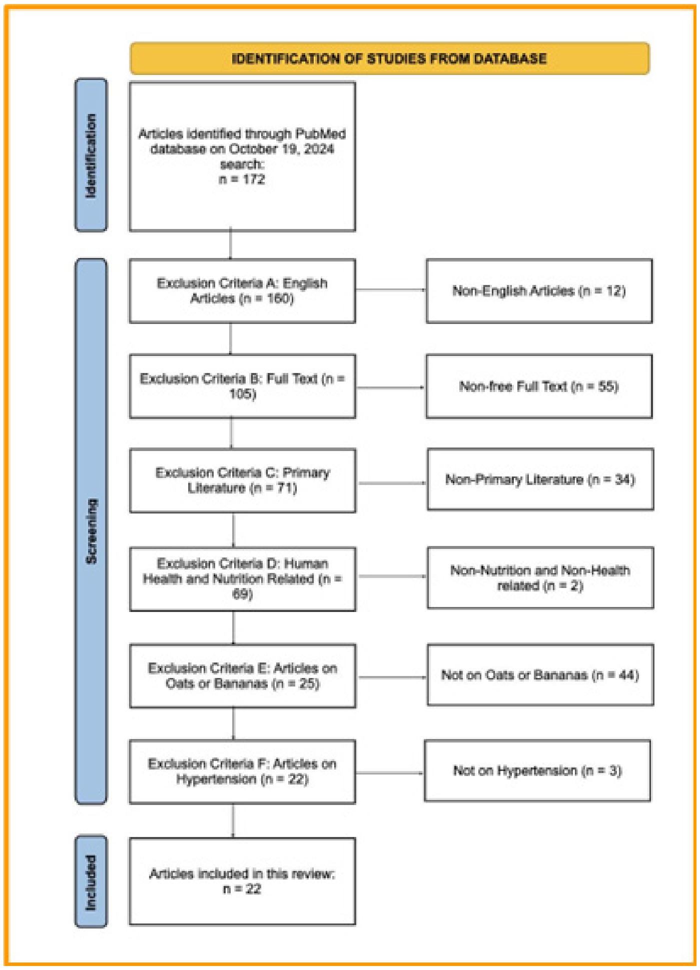

Figure 1: PRISMA Flowchart.

Themes	Sub-themes	Number of Articles	References	Percentage
1. Findings on Oats	Subtheme 1: Antihypertensive Components (by itself)	7	[20–26]	31.8%
	Subtheme 2: Highlighted Oat Products	5	[21, 27–30]	22.7%
	Subtheme 3: Effects of Oats in Combination	2	[26, 31]	9.1%
	Subtheme 4: Points of Contention	5	[21, 24, 26, 32, 33]	22.7%
2. Findings on Bananas	Subtheme 1: Antihypertensive Components (by itself)	2	[34, 35]	9.1%
	Subtheme 2: Highlighted Banana Products	2	[34, 36]	9.1%
	Subtheme 3: Effects of Bananas in Combination	1	[37]	4.5%
	Subtheme 4: Points of Contention	5	[34, 35, 37–39]	22.7%
3. Factors Affecting Regular Consumption	Subtheme 1: Internal	2	[34, 40]	9.1%
	Subtheme 2: External	1	[41]	4.5%

Table 1: Articles Related to the Respective Themes.

Theme 1.1: Antihypertensive Components of Oats (by itself). Beta-glucan is a soluble dietary fibre found in oats and recognised for its ability to lower blood cholesterol, which is a key biomarker for cardiovascular disease, including hypertension [42]. In Raj et al.'s animal study, male SHRs (spontaneously hypertensive rats) consuming beta-glucan have significantly lower systolic and diastolic blood pressure compared to control [43]. Malondialdehyde (a biomarker for lipid oxidation) and angiotensin II levels are also reduced in SHRs consuming beta-glucan. Lower malondialdehyde level suggests reduced oxidative stress, which is generally considered a major factor underlying the pathogenesis of cardiovascular disease, including hypertension [26, 43] while angiotensin II is key in the renin-angiotensin-aldosterone system (RAAS) to regulate blood pressure, sodium retention, vasoconstriction, endothelial dysfunction, and vascular injury [43]. Hence, lower angiotensin II implies lowered blood pressure; therefore, anti-hypertensive.

Moreover, beta-glucan consumption lowers low-density lipoprotein cholesterol (LDLC) levels of hypertensive individuals. A study on participants aged between 20 to 65 years old, who had total cholesterol levels between 5.17 mmol/L and 6.2 mmol/L, LDLC levels between 3.36 mmol/L and 4.91 mmol/L, and estimated 10-year cardiovascular risk <10%, the consistent consumption of the beta-glucan supplements resulted in a reduction in mean LDLC levels, by 12.2% after 4 weeks and by 15.1% after 8 weeks ($p < 0.01$ for both comparisons), with a decrease of 0.59 mmol/L in LDLC levels by the end of the intervention period [44]. These results mirror Ms Wolever et al.'s results, whereby the effects of the daily consumption of a beverage containing 3g of high-molecular-weight oat beta-glucan for 4 weeks were evaluated. An inverse relationship between oat beta-glucan consumption and LDL (reduced by about 6%), total cholesterol (reduced by 0.226 mmol/L), the ratio of total cholesterol to high-density lipoproteins (HDL)(reduced by 0.147), non-HDLC (reduced by 0.194 mmol/L), and Framingham cardiovascular disease risk (reduced by 0.474%) was established. Collectively, this resulted in a reduced cardiovascular risk by roughly 8% in healthy adults with pre-existing LDLC levels between 2 and 5 mmol/L [24]. When the consumption of beta-glucan is increased to at least 6g, it results in a significant reduction in total cholesterol levels from 234.90 ± 27.05 mg/dl to 227.57 ± 30.88 mg/dl [23]. Reduced blood cholesterol level is a significant contributor to the anti-hypertensive property of oats as for every 1 mg/dl increase in total cholesterol, LDLC, and non-HDL, the risk of hypertension increases by 0.2% [20].

Consumption of beta-glucan also improves diabetes-induced hypertension. When hypertensive and hyperinsulinemic patients consumed 5.5g of beta-glucan per day for 6 weeks; a 7.5 mmHg reduction in systolic blood pressure ($p < 0.01$), and a 5.5 mmHg reduction in diastolic blood pressure ($p < 0.02$) was observed [45]. Improved insulin sensitivity could be observed, whereby a lower production of total insulin was observed in response to a glucose load [45]. Increased insulin sensitivity is a key indicator of improvement in an individual's hypertension conditions, as insulin can cause hypertension via different pathways, such as increasing renal sodium reabsorption, acting the sympathetic nervous system, altering the transmembrane ion transport, and causing hypertrophy of resistance vessels [25]. Hence, reducing total insulin production can improve hypertension caused by hyperinsulinemia.

The second component of oats contributing to its anti-hypertensive properties would be its proteins and peptides. Oats has a relatively high protein content, with protein content of oat grain (crude protein content of 12-20%) higher than other cereals, including rice (7–10%), wheat (11–15%), and millets (7–11%), and contains comparatively more essential amino acids such as lysine, valine, isoleucine, threonine, histidine, and methionine than other grains [46]. Furthermore, the consumer's acceptability score of oat protein is higher than plant-based proteins derived from peas, lupin, and soy [46].

Oat proteins and peptides play a role in managing hypertension due to their effect on RAAS. The RAAS controls vasoconstriction and intravascular fluid volume through regulations of renin activity and angiotensin-I-converting enzyme (ACE-I) [47]. Hence, the inhibition of the aforementioned regulators is key to managing hypertension. Bioactive peptides found in oats have been found to contain renin inhibitory and ACE-I inhibitory peptide characteristics, with oat protein isolates having renin inhibition values ranging between 40.5% and 70.9% [47]. Crude oat protein extracts were able to inhibit ACE-1 activity by between 86.6% and 96.5%, which is a result of significant similarity to captopril, a group of chemical medications used to treat hypertension (Captopril expressed an ACE-I inhibition of 97.7%) [47]. Moreover, based on its bioavailability score, derived from the solubility percentage when introduced to saliva, gastric juice, and intestinal juice and centrifuged for 13,400× g for 10 min at room temperature, oat protein displayed greater ACE-I activity inhibition levels (score of 2) than some pea and wheat protein samples (score of 1), and a comparable result to other plant-based proteins, such as potato, fava bean, hydrolysed pea, and other pea and wheat protein samples (score of 2) [21]. Hence, as oat protein can inhibit ACE activity even after digestion, it is a viable option for hypertensive individuals to consume for its anti-hypertensive benefits.

Theme 1.2: Highlighted Oat Products. With the components of oats that contribute to their anti-hypertensive nature established, the types of oat products that can provide consumers its anti-hypertensive benefits should be discussed. This consideration must be made as the processing of the oats will affect the molecular weight and/or extractability of its beta-glucan, which in turn affects their ability to achieve the expected health benefits within a given dose [22]. The first oat product discussed would be whole and refined oats. Wholegrain oats consist of the endosperm, germ, and bran.

As previously mentioned, RAAS plays a key role in blood pressure control, and is regulated by angiotensin-I-converting enzyme (ACE-I) activity; hence, inhibitors of ACE-I are necessary in reducing hypertension. However, synthesised ACE-I inhibitors have significant side effects, including hypotension and hindered renal functioning [47]. As such, its natural-deriving counterpart found in food, such as oats, may be a more viable option. Of 7 oat varieties of dehulled and milled oats (namely Barra, Husky, Maesbro, Mascan, Rhapsody, Selwyn, and Vodka) tested in study, Barra oat had the highest levels of renin inhibition, with 70.9% inhibition; followed by Vodka oat, which had 66.1% inhibition [47]. Moreover, when compared to their synthesised counterparts, the protein isolates collected from oats expressed greater renin inhibition activity [47]. Protein extracted from Barra oat varieties displayed the highest ACE-I inhibition values of 96.5% when assessed at a concentration of 1 mg/mL, which is comparable with captopril, a synthesised ACE-I inhibitor used to treat hypertension [47, 48]. Hence, refined oats, especially of the Barra oat varieties, established their ability to reduce hypertension by inhibiting ACE-I and renin.

Pins et al.'s study showed that 73% of their hypertensive study participants experienced a reduction or cessation in anti-hypertensive medication consumption after 12 weeks of consuming whole grain oat-based cereals, while participants who were not able to reduce medication consumption experienced a significant reduction in blood pressure [49]. A reduction in total cholesterol levels by 24.2 mg/dL, LDLC levels by 16.2 mg/dL, and plasma glucose levels by 15.03 mg/dL were also recorded [49]. Hence, consumption of soluble fibre-rich whole oats can reduce dependency on antihypertensive medication by improving blood pressure control. As it improves lipid and glucose levels as well, it can also reduce the risk of cardiovascular diseases, which can contribute to worsening hypertension [49].

When wholegrain oats undergo refining processes; such as milling, pearling, polishing, and de-germing; some or all of the bran is removed; hence, the key difference between wholegrain and refined oats [29]. Refining oats reduces micronutrients, dietary fibre, and anti-nutritional components, which are usually found in the bran [29]. In consideration of the nutritional content of the bran, the second oat product discussed will be oat bran itself. Oat bran contributes to 30% of the dry weight of oat grain and is high in bioactive compounds, such as non-starch polysaccharides and polyphenols [50]. Oat bran also contains soluble and insoluble dietary fibres, such as the aforementioned beta-glucan, which has associations with cholesterol-lowering effects, serum glucose regulators and cardiac health enhancers [50].

The efficacy of oat bran consumption as a solution to hypertension was examined on 44 patients, aged 18 to 65 years and diagnosed with stage 1 hypertension [51]. After 3 months of consuming 30g of oat bran supplement (containing 8.9g of dietary fibre) per day while following a Dietary Approaches to Stopping Hypertension (DASH) diet, systolic and diastolic blood pressure were lowered, by 15.3±8.4 mmHg and 10.2±10.2 mmHg respectively. A decrease in 24-hour maximum systolic blood pressure and diastolic blood pressure, by 14.0±15.5 mmHg and 11.1±14.6 mmHg, respectively, was also noted, which was more significant than in patients who only followed the DASH diet (systolic blood pressure decreased by 1.9±8.0 mmHg). Out of 22 patients who underwent the DASH and oat bran diet, 7 patients adjusted their anti-hypertensive medication consumption, with 6 reducing and 1 ceasing consumption; in comparison, 2 patients following the DASH diet only increased their anti-hypertensive medication consumption. Hence, it can be concluded that oat bran consumption has anti-hypertensive benefits and can reduce anti-hypertensive medication dependency.

Consumption of oat bran can also reduce heart rate, which is an essential blood pressure management goal. Consumption of oat bran while following a DASH diet resulted in a lower 24-hour maximum heart rate than following a DASH diet only (93.24 ± 15.26 vs. 98.17 ± 16.99 bpm, $p = 0.049$) [30]. A significant reduction in the 24-hour average heart rate during daytime, from 75.15 ± 9.69 bpm to 71.03 ± 9.91 bpm ($p = 0.022$), and 24-hour maximum heart rate during daytime, from 103.03 ± 18.43 bpm to 93.24 ± 15.26 bpm ($p = 0.006$) was also noted. Such differences were not recorded for patients following the DASH diet only. Hence, oat bran can improve hypertensive conditions by reducing heart rate.

Even when consuming a less ideal diet, for example, a diet high in sucrose and low in protein, oat bran consumption may still provide anti-hypertensive benefits. In el Zein et al.'s study conducted on SHRs, it is not unforeseen that SHRs consuming a diet high in sucrose (calories: sucrose 52%, protein 15%, fats 33%) would have a significantly higher blood pressure than SHRs consuming a diet low in sucrose (calories: sucrose 13%, protein 52%, fats 35%), with blood pressures at 217 mm Hg ± 5 (SEM) and 187 mm Hg ± 4 (SEM respectively ($p < 0.0001$) [27]. However, SHRs consuming a high sucrose diet while also consuming oat bran (calories from fats were replaced with oat bran (10% w/w) expressed a significantly lower blood pressure compared to SHRs consuming a diet high in sucrose only, by 200 mm Hg ± 2 (SEM) ($p < 0.01$). Hence, oat bran can be consumed to reduce the hypertensive effects of high sucrose foods, which for humans could come from highly processed sugary foods; such as cookies, cakes, and sugar-sweetened drinks, amongst others.

Theme 1.3: Effects of Oats in Combination. The anti-hypertensive effects of oats consumption may be further enhanced when consumed in conjunction with diet or medication. Hydrochlorothiazide is a thiazide-type diuretic used to treat hypertension, through inhibition of sodium reabsorption in the distal convoluted tubules of the kidney by directly inhibiting the sodium chloride cotransporter, hence preventing sodium reabsorption and inducing natriuresis and diuresis effects [28]. When male SHRs were treated with a combination of oat beta-glucan (305 mg/kg/day) and hydrochlorothiazide (20 mg/kg/day); their body weight, systolic blood pressure, and diastolic blood pressure were lower than control [43]. This combined treatment also has benefits on cardiac structure and function, whereby the left ventricle internal dimension, interventricular septal wall thickness, and left ventricular posterior wall thickness of combination treatment male SHSRs were significantly higher than control; indicative of greater cardiac output and stroke volume. SHRs of both genders that underwent combination treatment had a significantly higher left ventricular ejection fraction compared to control, indicating improvement in their heart pumping function. Isovolumetric relaxation time was used to test for diastolic functional parameters, with combination treatment male SHRs having significantly lower values compared to control, suggesting that the treatment can prevent diastolic dysfunction. Hence, it can be deduced that the consumption of oats with hydrochlorothiazide (20 mg/kg/day) has synergy in improving hypertension conditions of hypertensive individuals via reducing blood pressure and improving heart structure and function.

A hypocaloric diet can enhance the anti-hypertensive properties of oats consumption, whereby the purpose of the diet is to decrease excess weight by a range of 5-10% of initial weight. When a hypocaloric diet (maintenance energy minus 4.2 MJ/day) with the addition of 45g of refined oats/day was followed for 6 weeks, a significant decrease in mean systolic blood pressure (oats −6 ± 7 mm Hg, $p = 0.026$), and significant improvements in total cholesterol (oats −0.87 ± 0.47 mmol/L, $p = 0.003$) and LDLC levels (oats −0.6 ± 0.41 mmol/L, $p = 0.008$) were observed when compared to their hypocaloric diet only counterparts (−1 ± 10 mm Hg, −0.34 ± 0.5 mmol/L, −0.2 ± 0.41mmol/L respectively) [52]. Such reduction in circulating cholesterol in the body can reduce the risk of hypertension stemming from excess body weight.

Theme 1.4: Points of Contention on Antihypertensive Effects of Oats. While the above studies support the consumption of oats due to their anti-hypertensive benefits, several papers refuted this claim. Davy et al.'s study claims that the study periods of other papers were too short to record long-term benefits. Their study concluded that when wholegrain oat (containing 14g of dietary fibre) was consumed daily for 12 weeks by individuals with high-normal blood pressure and Stage I hypertension, casual seated and supine arterial systolic and diastolic blood pressure and 24-hour ambulatory systolic and diastolic blood pressure showed no changes from measurements made before the test [31]. Moreover, a small but significant increase in nighttime diastolic blood pressure and mean arterial pressure was noted [31]. However, this study does support the notion that reduction in blood pressure could occur when consumption of oat fibre is greater than what was consumed in this study (increase by more than 30%), or that weight loss and changes in other dietary factors could be necessary events alongside oat fibre consumption to lower blood pressure [31]. This study hence proposes that the consumption of oats is a contributing, but not a lone factor, to reducing blood pressure. The importance of weight loss and dietary factors is further highlighted in Roswall et al.'s study conducted on Swedish women aged 29 to 49 years old [33]. Women who showed adherence to a healthy Nordic food index diet (high in vegetables, fruits, fish, poultry, tomato, cereal inclusive of oatmeal, and low-fat dairy products) showed no difference in cardiovascular disease risk compared to women who did not follow a health Nordic food index diet, with the distribution of the women developing ischaemic heart disease, stroke, arrhythmia, thrombosis, hypertensive disease, and others relatively similar for both diet groups [33]. Interestingly, women who followed a healthy Nordic food index diet were noted to have greater overall energy intakes, consumed more processed meats, and were less likely to abstain from consuming alcohol, which could all contribute to increasing blood pressure, hence hypertension [33]. Hence, it can be deduced that following a hypocaloric diet and minimising the consumption of foods that would exacerbate hypertension conditions are necessary for the anti-hypertensive benefits of oats consumption to be felt.

While the consumption of oats and hydrochlorothiazide can improve cardiac structure and function, it can also cause an increase in ventricular wall hypertrophy (of the interventricular septal wall thickness, left ventricular posterior wall thickness, and left ventricular internal dimensions) at diastole [43]. This observation indicates an undesirable effect of combination treatment on cardiac structural parameters in SHRs, as ventricular wall hypertrophy can impair diastolic function via prolongation of the isovolumetric relaxation time, hence increasing the risk of mortality due to heart failure [43]. Furthermore, the effectiveness of oat consumption in reducing hypertension may be dependent on gender. In a study done on SHRs, no blood pressure lowering effects were noted between beta-glucan-treated female SHRs and untreated female SHRs, compared to the mean decrease in blood pressure of approximately 20 mmHg noted in beta-glucan treated male SHRs when compared to untreated male SHRs [43]. The combination treatment of beta-glucan and hydrochlorothiazide was also not effective in lowering blood pressure in treated female SHRs, and while a clear trend towards a decrease in isovolumetric relaxation time was noted, there was no significant lowering recorded post-treatment [43]. This lack of effect of beta-glucan on blood pressure for females could be due to females with hypertension tending to have lesser blood pressure control, therefore diminishing the effects of beta-glucan [43]. Hence, this shows that oat consumption is less effective in improving diastolic function for females. However, the consumption of oats may indirectly improve hypertension conditions of females via improvement in blood lipid levels, whereby the consumption of beta-glucan has a slight but significantly greater LDLC lowering effect of 16.3% for females compared to males, who experienced a 14.9% decrease [44].

In addition, age may play a role in the efficacy of oat consumption on hypertension improvement, whereby younger patients consuming beta glucan supplements experienced a greater reduction in LDLC, by 16.4%, when compared to their older counterparts, who experienced a 14.7% reduction [44].

Lastly, it has been previously mentioned that while oat protein isolates were shown to inhibit renin significantly in vitro, the same cannot be said for their synthesised counterparts. This noted difference could be due to the presence of other compounds in the organically derived protein isolates, such as phenolic compounds [47]. Hence, the consideration is that while oats consumption can reduce hypertension, the aspect of it which provides such benefit is not due to its protein isolates, but due to its phenolic compounds.

Theme 2.1: Antihypertensive Components of Banana (by itself). Banana is another food commonly consumed for its antihypertensive benefits, which can be accredited to its phytochemical compounds, electrolytes, and vitamin C contents. Phytochemical compounds, specifically bioactive phenolic compounds, are found in most plant tissues as secondary metabolites synthesized through the shikimic acid and phenylpropanoid pathways [32]. Electrolytes are essential for basic life functioning, such as maintaining electrical neutrality in cells and generating and conducting action potentials in the nerves and muscles, and high or low levels of electrolytes disrupt normal bodily functions and can lead to life-threatening complications [53]. Optimal consumption levels of the various electrolytes (such as sodium, potassium, calcium, and magnesium) have beneficial blood pressure-lowering effects [54]. Electrolytes found in bananas, with emphasis on potassium, and other nutrients such as vitamin C have been positively correlated with lower incident home hypertension [35]. Vitamin C primarily functions as a potent antioxidant and radical scavenger, providing defence for cell constituents from oxidative stress caused by reactive free oxygen species and free radicals [55]. Inadequate Vitamin C consumption has been associated with cardiovascular condition risks, such as high blood pressure, endothelial dysfunction, heart disease, atherosclerosis, and stroke [55]. The banana fruit is composed of high phenolic compounds contents; such as catechin, epicatechin, lignin, tannin, and anthocyanin; as well as carotenoids, flavonoids, biogenic amines, phytosterols, and other phytochemicals; which contribute to its high antioxidant potential when compared to various berries, herbs, and vegetables [56]. These compounds highlighted have exhibited antiviral, anti-thrombotic, antiallergenic, anti-inflammatory, anti-bacterial, anti-diabetic, anti-cancer, and vasodilatory properties; hence, consumption of bananas can provide health-promoting benefits and improvement in well-being for humans [56].

Theme 2.2: Highlighted Banana Products. From data extrapolated from the Swedish Cardiopulmonary Bioimage Study (SCAPIS), a decrease in the likelihood of incident home hypertension within a 4-year period was noted when banana consumption was more frequent, for those aged 50 to 65 years of age [35]. This held especially true for women, where there was a significant association between lower home diastolic blood pressure levels and more frequent consumption of bananas [35]. As diastolic blood pressure levels are a strong indicator of future coronary heart diseases for the age group of the participants, it can hence be noted that the improvement of the diastolic blood pressure can reduce hypertension, and hence the risk of cardiovascular diseases [35]. This is further supported by Sakar et al.'s clinical trial, whereby healthy human volunteers were subjected to a cold stress test to induce hypertension [34]. The consumption of bananas before the cold stress test resulted in a significantly smaller rise in systolic blood pressure, diastolic blood pressure, and mean arterial blood pressure without much effect on heart rate and peak expiratory flow rate when compared to the control volunteers [34]. A significant decrease in plasma ACE activity was also observed for the test volunteers, therefore inhibiting hypertension from occurring [34].

Theme 2.3: Effects of Bananas in Combination with Other Foods. When consumption of bananas and apples, totalled 3 to 6 times combined per week, a significant decrease in all-cause mortality of hypertensive individuals was noted, whereby a 0.57 multivariable-adjusted hazard ratio (measurement for all-cause mortality risk adjusted for gender, age, race, education level, ratio of family income to poverty rate, smoking, hypercholesterolemia, diabetes, cardiovascular disease, stroke, lung disease, and failing kidneys) was calculated, which was lower than banana (0.71) consumption alone [36]. Hence, the regular consumption of bananas with apples can prevent the worsening of hypertension conditions.

Theme 2.4: Points of Contention on Antihypertensive Effects of Banana. Similarly to oats, some studies raise concerns about the consumption of bananas to improve hypertension conditions. One such concern is due to the presence of polyphenol oxidase. Polyphenol oxidase is a group of enzymes found in the banana pulp that is associated with enzymatic browning and nutritive loss, as the fruit ripens [37]. Polyphenol oxidase causes significant degradation of methyldopa, a type of anti-hypertensive medication administered to patients with heart diallers, renal failures, diabetes, and pregnancy-induced hypertension [57]. In a pharmaceutical experiment conducted by Uesawa et al., the concentration of a methyldopa solution decreased by 60% after 5 minutes, to 0.5% after 30 minutes when mixed with a banana juice mixture [57]. Hence, banana consumption could cause significant drug-food interaction due to the rapid reaction between them, possibly resulting in sustained hypertension due to the diminished effectiveness of their anti-hypertensive medication. Due to the disruptive nature of banana consumption for patients on anti-hypertensive medication, bananas hence should not be recommended for patients who require anti-hypertensive medication to moderate their symptoms (patients who have more severe stages of hypertension).

Not covered in the studies above, banana peels are also part of the banana that is consumed in some communities. Banana peels have long been a popular folklore remedy for hypertension and cardiovascular-related diseases in the northern part of Nigeria, namely those derived from the *Musa acuminata* species [39]. However, in a study conducted on experimental Wistar rats, while the peel of the Musa acuminata did not have harmful effects on the rats, the peel from bananas deriving from the Saro cultivator is nephrotoxic, causing an increase in the level of serum creatinine and urea in their liver when they consumed peel extracts from the Saro cultivator [39]. Serum creatinine and urea are common biomarkers for the prediction of renal failure, due to their elevated presence when there is a dysfunction of the kidney, therefore extract of Saro peel cultivator may impair renal function at the comparative human dose levels [39]. Hence, as banana peel from the Saro variety presents a significant disruption to the liver, which plays a key role in maintaining biological equilibrium in organisms, banana peel of the Saro species should hence be avoided as it may even cause or exacerbate hypertension in individuals if consumed.

Back to the banana fruit, while the anti-hypertensive properties of bananas can be accredited to their phenolic compounds, their phenolic qualities are dependent on their stage of ripeness. The phenolic compound content found in green bananas decreases significantly on day 4 of storage in a controlled atmosphere ripening room, followed by insignificant variations until day 11 of storage, then a significant increase until the end of the experiment, day 21 [56]. Green bananas have been reported to have lower total phenolic content than ripened fruits [56]. Hence, for the anti-hypertensive benefits from banana consumption to be felt, bananas should be consumed either within 4 days from when its green, unripe stage, or from day 11 onwards from when it is green, such that its phenolic content is at its highest, therefore having the most vasodilatory effect. This may be difficult for consumers to ensure as unless the bananas are recorded and labelled, there is no definitive way to know how many days it has been since the bananas were green. Human judgement of bananas' ripeness tends to be inconsistent, being subjective and prone to error, therefore an ineffective way of ascertaining the optimal period of when to consume the banana [38].

While observable associations between the frequency of banana consumption and home blood pressure levels were true for women, such associations were not noted for men [35]. In a 10-year follow-up study conducted on hypertensive individuals, individuals consuming bananas 3 to 6 times per week exhibited a significant reduction of 24% in risk of all-cause mortality when compared to individuals who consume bananas less than once a month [36]. However, consuming bananas more than 6 times a week is not correlated with a reduction in all-cause mortality risk [36]. Hence, while it can be concluded that consuming bananas does have benefits in improving hypertension conditions, this benefit is only noted when consumption is at a specific frequency, therefore quantity consumed should be considered.

Theme 3: Factors Affecting Regular Consumption of Oats and Bananas. Consistent and regular consumption of oats and bananas is required for their anti-hypertensive benefits to be reaped. Furthermore, cessation of the consumption of oats and bananas may revert the hypertensive conditions of an individual [44]. When consumption of oats ceased after 8 weeks of consistent consumption, both total cholesterol and LDLC levels rapidly returned to levels prior to those 8 weeks. Lipid plasma levels assessed after 2 weeks of consumption cessation were comparable with those measured before consumption, and not significantly different from those observed 4 weeks after consumption cessation [44]. Hence, considerations of the factors affecting the adherence to regular consumption of oats and bananas are key to ensuring long-term improvement in hypertension. These factors affecting consumption adherence can be categorised depending on their origin; if the influence comes from the individual, it can be classified as an internal factor, and if the influence comes from their environment, it can be classified as an external factor. Internal factors include gender, efficacy, optimism, and satisfaction with life, while external factors include price.

From the data extrapolated from SCALPIS, it was noted that between men and women, men were reported to consume less than 5 servings of fruits per week [35]. Hence, while the data recorded on the effects of banana (and apple) consumption on the hypertension conditions of men was not effective, it could be unrepresentative of the actual benefits of regular banana consumption for men. It can also be noted that gender would play a role in the adherence to regular consumption of bananas, which would affect its efficacy in improving hypertension conditions. Even within the female population, adherence to a regular consumption of oats and bananas is dependent on a multitude of factors. In a study conducted on post-menopausal women diagnosed with arterial hypertension and treated with hypotensive agents, higher levels of self-efficacy, optimism, and satisfaction with life were associated with greater consumption of oatmeal, amongst other whole foods such as whole grains, raw vegetables, and fruits [58]. Lower levels of self-efficacy, optimism, and satisfaction with life not only indicated lower consumption of the aforementioned food groups, but also increased consumption of foods that could worsen their hypertension and put them at elevated risk of cardiovascular degenerative disorders, with such foods including white bread, high-fat cottage cheese, pork meat and sausages, fast food products, and sweets and pastries [58]. Hence, lower levels of self-efficacy, optimism, and satisfaction with life could make postmenopausal women with hypertension more prone to making less rational dietary choices which could reduce the efficacy of consuming oats and bananas in reducing the risk or progression of hypertension.

Perception or actual cost of food may reduce the consumption of bananas. In Drewnowski et al.'s study conducted on American adults, diets with greater amounts of potassium were associated with higher diet costs, with the cost difference between the highest and lowest potassium intakes was USD$1.49 [40]. While bananas were evaluated to be a low-cost source of potassium and can reduce the sodium-to-potassium ratio in an individual due to its low sodium content, regular consumption of bananas may still prove to be difficult due to fresh foods being less common in lower socio-economic environments, hence reducing accessibility and increasing the cost required for individuals living in such environments to purchase bananas, therefore acting as a barrier to entry, resulting in lower consumption [41].

Practical Implications. As per the studies discussed, the recommended amount of beta-glucan to be consumed ranged from 3g to 6g. To meet the minimum amount of 3g of beta-glucan, 75g of wholegrain oats, or 55g of oat bran must be consumed daily [42]. While this amount may be doable in the short run, it could become an unrealistic goal for someone to consume such amounts in the long run, which they would need to do so to experience the anti-hypertensive benefits of consuming oats (Figure 2).

Efforts to incorporate oats into one's diet would also have to consider processing, whereby greater processing of oats causes a greater extent of oat tissue disruption, which significantly reduces the effectiveness of beta-glucan in reducing hypertension [59]. Moreover, it has also been highlighted that alongside a diet inclusive of oats and bananas, other dietary intakes can potentially affect the anti-hypertensive benefits of consuming oats and bananas. The diets highlighted above that did not hinder or diminish the anti-hypertensive benefits include a Mediterranean diet, with controlled consumption of dairy and red meat-derived products, a hypocaloric diet, and DASH diet, while diets with higher energy intake, or consisted of foods such as white bread, high-fat cottage cheese, pork meat and sausages (and other processed meats), fast food products, sweets and pastries, and alcohol increased the risk of hypertension development [23, 30, 33, 44, 51, 52, 58]. Hence, commitment to reducing hypertension has to include the rest of one's diet, not just the consumption of oats and bananas, therefore further increasing the mental load on an individual, making the diet less sustainable to follow in the long run.

Panel A

Panel B

Panel C

Figure 2: Preparation of 75g of oats. Panel A shows 75g of dry oats. Panel B shows 75g of dry oats (from Panel A) cooked in 260 ml of water. Panel C shows the result of Panel B, an estimated 342 ml of oats in a glass container (radius = 6.6 cm, height 2.5 cm)

Future Research Directions

While oats and banana are commonly eaten together and have both established anti-hypertensive properties, there is a lack of studies documenting their effects when consumed together. Hence, further research can explore if there are synergetic effects of consuming oats and banana together on improving hypertension conditions, as well as the amounts that should be consumed to maximise the anti-hypertensive effects. Current findings evaluating the effects of oats and banana consumption are limited to certain products; such as cereals, supplements, or as-is [35, 49, 51]. This may not realistically reflect how an individual would consume oats and bananas in the long run. Hence, further research can also be done into the different ways an individual can process oats and bananas for consumption without reducing their anti-hypertensive contents. This would allow consumers a variety of ways; hence, the ability to choose how they would want to consume oats and bananas, promoting satiation, which is beneficial for hypertensive individuals with excess body fat [60].

Conclusion

Consumption of oats or bananas does provide anti-hypertensive benefits but must be consumed regularly and consistently for an extended period for their benefits, such as reduction in reliance on anti-hypertensive medication, to be reaped. A healthy diet must also be consumed in conjunction with oats and bananas consumption, as high energy intake and the consumption of processed, fatty, sugary foods can not only hinder but worsen the hypertensive conditions of an individual regardless of oats and bananas consumption. Other factors that affect the efficacy of oats and banana consumption include the type and quality of the oats and bananas, foods and medications consumed alongside oats and bananas, gender, self-efficacy, optimism, satisfaction with life, and price.

Supplementary Materials

Supplementary materials for this study can be downloaded at https://bit.ly/OatBanana_HighBP_SR.

Acknowledgement

Laura would like to express her gratitude to her classmates (Nicholas Jia Le Yip, Jun Kai Soh, Charmaine Zi Xuan Lim, Natalie Lileen Chew, Riko Keting Sng, Estelle Yun Chi Sim) for their unwavering support.

References

1. Abdalla M, Bolen SD, et al;(2023) "Implementation Strategies to Improve Blood Pressure Control in the United States"; A Scientific Statement From the American Heart Association and American Medical Association. Hypertension 80(10): e143–e157.
2. Chan GC, Teo BW, et al; (2021). "Hypertension in a multi-ethnic Asian population of Singapore". The Journal of Clinical Hypertension 23(3):522–528.
3. Flack JM, Adekola B (2020). "Blood pressure and the new ACC/AHA hypertension guidelines". *Trends in Cardiovascular Medicine* 30(3):160–164.
4. Pilakkadavath Z, Shaffi M (2016). "Modifiable risk factors of hypertension: A hospital-based case–control study from Kerala, India. J*ournal of Family Medicine and Primary Care* 5(1):114–119.
5. Feingold KR et al; (2000). "Obesity and Dyslipidemia".
6. Ebong IA, Goff DC, et al; (2014) "Mechanisms of heart failure in obesity". *Obesity Research & Clinical Practice* 8(6): ppe540–e548.
7. Kamran A, Azadbakht L, et al; (2014) "Sodium Intake, Dietary Knowledge, and Illness Perceptions of Controlled and Uncontrolled Rural Hypertensive Patients". *International Journal of Hypertension*.
8. Perez V, Chang ET (2014) "Sodium-to-Potassium Ratio and Blood Pressure, Hypertension, and Related Factors". *Advances in Nutrition* 5(6): pp712–741.
9. Stone MS, et al; (2016) "Potassium Intake, Bioavailability, Hypertension, and Glucose Control". *Nutrients* 8(7):444.

10. Lee JH, et al; (2024) "The Development of New Functional Foods and Ingredients". *Foods* 13(19):3038.
11. Bouchard J, et al; (2022) "Impact of oats in the prevention/ management of hypertension". *Food Chemistry* 381: pp132198.
12. Lin H-L, et al; (2023) "Effect Evaluation of Banana on Improving Hyperglycemia and Hypertension in Diabetic Spontaneously Hypertensive Rats". *Natural Product Communications* 18(11):1934578X231213225.
13. Brown CM (1980) "Oat. Hybridization of Crop Plants" *John Wiley & Sons, Ltd*, pp 427–441.
14. Khan K, et al; (2018) "The effect of viscous soluble fiber on blood pressure: A systematic review and meta-analysis of randomized controlled trials". *Nutrition, metabolism, and cardiovascular diseases*: NMCD 28(1): pp3–13.
15. Bhuia MS, et al; (2023) "Hirsutine, an Emerging Natural Product with Promising Therapeutic Benefits: A Systematic Review". *Molecules* (Basel, Switzerland) 28(16): pp6141.
16. Liu Q, et al; (2023) "Fructose-containing food sources and blood pressure: A systematic review and meta-analysis of controlled feeding trials". *PloS One* 18(8): e0264802.
17. Williams PG (2014) "The benefits of breakfast cereal consumption: a systematic review of the evidence base". *Advances in Nutrition* (Bethesda, Md) 5(5): pp636S-673S.
18. Zhu R, et al; (2023) "Effects of cereal bran consumption on cardiometabolic risk factors: A systematic review and meta-analysis". *Nutrition, metabolism, and cardiovascular diseases*: NMCD 33(10): pp1849–1865.
19. Xi H, et al; (2023) "Effect of Oat Consumption on Blood Pressure: A Systematic Review and Meta-Analysis of Randomized Controlled Trials". *Journal of the Academy of Nutrition and Dietetics* 123(5): pp809–823.
20. Chen S, Cheng W (2022) "Relationship Between Lipid Profiles and Hypertension: A Cross-Sectional Study of 62,957 Chinese Adult Males". *Frontiers in Public Health* 10:895499.
21. Dugardin C, et al; (2020) "Explorative Screening of Bioactivities Generated by Plant-Based Proteins after In Vitro Static Gastrointestinal Digestion". *Nutrients* 12(12): pp3746.
22. Henrion M, et al; (2019) "Cereal B-Glucans: The Impact of Processing and How It Affects Physiological Responses". *Nutrients* 11(8): pp1729.
23. Momenizadeh A, et al; (2014) "Effects of oat and wheat bread consumption on lipid profile, blood sugar, and endothelial function in hypercholesterolemic patients: A randomized controlled clinical trial". *ARYA atherosclerosis* 10(5): pp259–265.
24. Ms Wolever T, et al; (2021) "An Oat β-Glucan Beverage Reduces LDL Cholesterol and Cardiovascular Disease Risk in Men and Women with Borderline High Cholesterol: A Double-Blind, Randomized, Controlled Clinical Trial". *The Journal of Nutrition* 151(9): pp2655–2666.
25. Salvetti A, et al; (1993) "The inter-relationship between insulin resistance and hypertension". *Drugs* 46 Suppl 2:149–159.
26. Tsikas D (2017) "Assessment of lipid peroxidation by measuring malondialdehyde (MDA) and relatives in biological samples: Analytical and biological challenges". *Analytical Biochemistry* 524: pp13–30.
27. el Zein M, et al; (1990) "Influence of oat bran on sucrose-induced blood pressure elevations in SHR". *Life Sciences* 47(13): pp1121–1128.
28. Herman LL, et al; (2025) "Hydrochlorothiazide". *StatPearls (StatPearls Publishing, Treasure Island (FL))*.
29. Jones JM, et al; (2020) "Perspective: Whole and Refined Grains and Health—Evidence Supporting "Make Half Your Grains Whole." *Advances in Nutrition* 11(3): pp492–506.
30. Ju Y, et al; (2022) "Effect of Dietary Fiber (Oat Bran) Supplement in Heart Rate Lowering in Patients with Hypertension: A Randomized DASH-Diet-Controlled Clinical Trial". *Nutrients* 14(15): pp3148.
31. Davy BM, et al; (2002) "Oat consumption does not affect resting casual and ambulatory 24-h arterial blood pressure in men with high-normal blood pressure to stage I hypertension". *The Journal of Nutrition* 132(3): pp394–398.
32. de la Rosa LA, et al; (2019) "Chapter 12 - Phenolic Compounds. Postharvest Physiology and Biochemistry of Fruits and Vegetables, ed Yahia EM" *Woodhead Publishing*, pp 253–271.
33. Roswall N, et al; (2015) "No association between adherence to the healthy Nordic food index and cardiovascular disease amongst Swedish women: a cohort study". *Journal of Internal Medicine* 278(5): pp531–541.
34. Sarkar C, et al; (1999) "Effect of banana on cold stress test & peak expiratory flow rate in healthy volunteers". *The Indian Journal of Medical Research* 110: pp27–29.
35. Ström E, et al; (2022) "Associations between fruit consumption and home blood pressure in a randomly selected sample of the general Swedish population". *Journal of Clinical Hypertension* (Greenwich, Conn) 24(6): pp723–730.
36. Sun C, Li J, et al; (2024) "The correlation between fruit intake and all-cause mortality in hypertensive patients: a 10-year follow-up study". *Frontiers in Nutrition* 11: pp1363574.
37. Wohlt D, et al; (2021) "Effects of Extraction Conditions on Banana Peel Polyphenol Oxidase Activity and Insights into Inactivation Kinetics Using Thermal and Cold Plasma Treatment". *Foods* 10(5): pp1022.
38. Adebayo SE, et al; (2016) "Prediction of quality attributes and ripeness classification of bananas using optical properties". *Scientia Horticulturae* 212: pp171–182.
39. Edenta C, et al; (2017) "Effects of Aqueous Extract of Three Cultivars of Banana (Musa acuminata) Fruit Peel on Kidney and Liver Function Indices in Wistar Rats". *Medicines* (Basel, Switzerland) 4(4):77.
40. Drewnowski A, et al; (2015) "The relation of potassium and sodium intakes to diet cost among U.S. adults". *Journal of Human Hypertension* 29(1): pp14–21.
41. Crawford B, et al; (2017) "Socioeconomic differences in the cost, availability and quality of healthy food in Sydney". *Australian and New Zealand Journal of Public Health* 41(6):567–571.

42. Hughes J, Grafenauer S (2021) "Oat and Barley in the Food Supply and Use of Beta Glucan Health Claims". *Nutrients* 13(8): pp2556.
43. 43. Raj P, et al; (2023) "Oat Beta-Glucan Alone and in Combination with Hydrochlorothiazide Lowers High Blood Pressure in Male but Not Female Spontaneously Hypertensive Rats". *Nutrients* 15(14): pp3180.
44. Cicero AFG, et al; (2020) "A randomized Placebo-Controlled Clinical Trial to Evaluate the Medium-Term Effects of Oat Fibers on Human Health: The Beta-Glucan Effects on Lipid Profile, Glycemia and inTestinal Health (BELT) Study". *Nutrients* 12(3): pp686.
45. Keenan JM, et al; (2002) "Oat ingestion reduces systolic and diastolic blood pressure in patients with mild or borderline hypertension: a pilot trial". *The Journal of Family Practice* 51(4): pp369.
46. Rafique H, et al; (2022) "Dietary-Nutraceutical Properties of Oat Protein and Peptides". *Frontiers in Nutrition* 9:950400.
47. Bleakley S, et al; (2017) "Predicted Release and Analysis of Novel ACE-I, Renin, and DPP-IV Inhibitory Peptides from Common Oat (Avena sativa) Protein Hydrolysates Using in Silico Analysis". *Foods* (Basel, Switzerland) 6(12):108.
48. Marte F, et al; (2024) "Captopril". StatPearls [Internet] (StatPearls Publishing).
49. Pins JJ, et al; (2002) "Do whole-grain oat cereals reduce the need for antihypertensive medications and improve blood pressure control?" *The Journal of Family Practice* 51(4): pp353–359.
50. Mustafa G, et al; (2022) "Comparative Study of Raw and Fermented Oat Bran: Nutritional Composition with Special Reference to Their Structural and Antioxidant Profile". *Fermentation* 8(10): pp509.
51. Xue Y, et al; (2021) "The effect of dietary fiber (oat bran) supplement on blood pressure in patients with essential hypertension: A randomized controlled trial". *Nutrition, metabolism, and cardiovascular diseases*: NMCD 31(8): pp2458–2470.
52. Saltzman E, et al; (2001) "An oat-containing hypocaloric diet reduces systolic blood pressure and improves lipid profile beyond effects of weight loss in men and women". *The Journal of Nutrition* 131(5): pp1465–1470.
53. Shrimanker I, Bhattarai S (2025) "Electrolytes. StatPearls" (StatPearls Publishing, Treasure Island (FL)).
54. Iqbal S, et al; (2019) "The Effect of Electrolytes on Blood Pressure: A Brief Summary of Meta-Analyses". *Nutrients* 11(6): pp1362.
55. Morelli MB, et al; (2020) "Vitamin C and Cardiovascular Disease: An Update". *Antioxidants* 9(12): pp1227.
56. Kritsi E, et al; (2023) "otential Health Benefits of Banana Phenolic Content during Ripening by Implementing Analytical and In Silico Techniques". *Life* (Basel, Switzerland) 13(2): pp332.
57. Uesawa Y, Mohri K (2010). "Degradation of Methyldopa by Banana". Pharmaceuticals (Basel, Switzerland) 3(3): pp441–447.
58. Gacek M (2014) "Individual differences as predictors of dietary patterns among menopausal women with arterial hypertension". *Przegląd Menopauzalny = Menopause Review* 13(2): pp101–108.
59. Grundy MM-L, et al; (2018). "Processing of oat: the impact on oat's cholesterol lowering effect". *Food & Function* 9(3): pp1328–1343.
60. Redden JP, et al; (2017). "The ability to choose can increase satiation". *Journal of Personality and Social Psychology* 112(2): pp186–200.