

## **ANALYSIS OF FERMENTED RICE BRAN, PHOSPHATE INTAKE, AND SODIUM INTAKE ON BLOOD PRESSURE: A REVIEW**

### ***Analisis Pengaruh Fermentasi Rice Bran, Asupan Fosfat, dan Natrium Terhadap Tekanan Darah***

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#### **ABSTRACT**

The number of people with hypertension continues to increase every year. Several foods contain nutrients that can affect blood pressure. They are rice bran fermentation, phosphate intake, and sodium intake. This study aims to analyze the effect of fermented rice bran, sodium, and phosphate intake on blood pressure through a review of literature. This research is a literature narrative study. That is the analysis of fermented rice bran, phosphate intake, and sodium effect on blood pressure. Seven kinds of literature met the inclusion criteria, with most of the designs being cross-sectional and experimental study designs with a large sample of the majority of the top 20 human respondents and more than ten experimental animals (rats). The results showed that fermentation of rice bran could lower blood pressure through ACE (Angiotensin-Converting Enzyme) inhibitor compounds that inhibit angiotensin I turning into angiotensin II with a p-value<0.05 in experimental animals (rats). In addition, a high intake of phosphate or sodium can increase blood pressure By narrowing of blood vessels and make the heart work heavier with a p-value<0.05 in the healthy human subject, hypertension sufferers, and experimental animals (rats). Rice bran fermentation has significantly reduced (rat) blood pressure. High intake of phosphate or sodium can increase blood pressure in healthy humans, hypertensive patients, and animal studies.

**Keywords:** blood pressure, fermented rice bran, phosphate intake, sodium intake

#### **ABSTRAK**

Jumlah penderita hipertensi terus meningkat setiap tahunnya. Beberapa makanan mengandung nutrisi yang dapat mempengaruhi tekanan darah. Makanan tersebut adalah fermentasi bekatul, asupan fosfat, dan asupan natrium. Penelitian ini bertujuan untuk menganalisis pengaruh asupan bekatul fermentasi, natrium, dan fosfat terhadap tekanan darah melalui tinjauan pustaka. Penelitian ini merupakan penelitian studi literatur yang menganalisis pengaruh Fermentasi Rice Bran, asupan fosfat, dan natrium terhadap tekanan darah. Tujuh jenis literatur memenuhi kriteria inklusi, dengan sebagian besar desain merupakan desain studi cross-sectional dan eksperimental dengan sampel dari 20 responden manusia dan lebih dari sepuluh hewan percobaan (tikus). Hasil penelitian menunjukkan fermentasi Rice Bran dapat menurunkan tekanan darah melalui senyawa penghambat ACE (Angiotensin-Converting Enzyme) yang menghambat perubahan angiotensin I menjadi angiotensin II dengan nilai  $p < 0,05$  pada hewan coba (tikus). Selain itu, asupan fosfat atau natrium yang tinggi dapat meningkatkan tekanan darah disebabkan oleh penyempitan pembuluh darah dan membuat jantung bekerja lebih berat, dengan nilai  $p < 0,05$  pada subjek manusia sehat, penderita hipertensi, dan hewan percobaan (tikus). Fermentasi bekatul secara

*signifikan menurunkan tekanan darah (tikus). Asupan fosfat atau natrium yang tinggi dapat meningkatkan tekanan darah pada pasien sehat, pasien hipertensi, dan hewan percobaan.*

**Kata Kunci** : *asupan fosfat, asupan natrium, fermentasi rice bran, tekanan darah*

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## INTRODUCTION

Hypertension is one of the most common diseases in Indonesian society.<sup>1</sup> Based on the 2018 Riskesdas, the prevalence of hypertension based on the measurement of 18 years was 34.1%. The highest was in South Kalimantan (44.1%), while the lowest was in Papua (22.2%). Hypertension occurs in the age group 31-44 years (31.6%), age 45-54 years (45.3%), and age 55-64 years (55.2%). Hypertension is most common in women compared to men<sup>2</sup>.

Hypertension is one of the risk factors that can be modified or changed in type 2 diabetes mellitus, although hypertension does not relate significantly to the incidence of type 2 diabetes mellitus.<sup>3</sup>

Various factors that cause hypertension are divided into two major groups, congenital and irreversible factors such as age, gender, genetics, and modifiable factors such as diet/intake, physical activity, and others.<sup>4</sup>

Looking at the current consumption patterns of people who tend to consume fast food high in salt (sodium) and fat can aggravate hypertension because it can lead to peripheral prisoner resistance and increased blood pressure.<sup>5</sup> In addition, excessive phosphate consumption from fast food can increase in blood pressure, whereas the current recommended daily consumption for inorganic phosphate is 700 mg, according to the National Academy of Medicine.<sup>6</sup>

The use of functional food can be an alternative to handling hypertension, such as rice bran. Fermented rice bran using fungi and

bacteria can be beneficial for overcoming metabolic syndrome, one of which can lower blood pressure by inhibiting the activity of serum ACE inhibitors and is also rich in other nutrients.<sup>7</sup>

Rice bran has good potential to be used because it has high antioxidants and can lower blood pressure, through the inhibition of work angiotensin-converting enzyme (ACE).<sup>8</sup> Fermented rice bran has a higher nutritional content than non-fermented.<sup>7</sup> Based on the research results rice bran fermentation in supplements form can improve certain medical conditions such as hypertension, colitis, and other metabolic syndromes. Unfortunately, the use of rice bran is still limited and only for animal feed.<sup>9</sup>

Researchers are also interested in analyzing the effect of sodium on blood pressure, where sodium causes the body to retain water at levels that exceed the body's normal threshold to increase blood volume and high blood pressure<sup>10</sup>. Besides sodium, researchers are also interested in analyzing the effect of phosphate on blood pressure because high phosphate intake is proven to increase blood pressure.<sup>11</sup>

## METHOD

### Materials

This research is a literature narrative study using the Traditional Review method, which analyzes the effect of fermented rice bran, phosphate intake, and sodium on blood pressure. The journal used uses the experimental method. Search articles or

journals using keywords aims to expand or group search articles or journals. That it can make it easier to determine the journal article that will use. The keywords used in this study were "rice bran fermentation," "phosphate intake," "sodium intake," and "blood pressure."

Based on the results of a literature search through Google Scholar, Sinta, and PubMed publications using the keywords "fermented rice bran" or "fermented rice bran," "phosphate intake" or "phosphate intake," "sodium intake," or "sodium intake," "pressure blood" or "blood pressure," and "hypertension". Only 7 journals that match the research keywords that were obtained from journals published in the last five years (2015-2020). Final journals can be analyzed according to the formulation of the problem from the Google Scholar, Pubmed, and Sinta databases.

## RESULTS

There is a journal that studies the effect of high intake of phosphate on increasing blood pressure and healthy human subjects. Moreover, the statistical test result is  $p < 0.05$ . A significant effect of high intake of phosphate in increasing blood pressure in healthy humans. Likewise for the results of 3

other research journals on the effect of high sodium intake on blood pressure, with statistical test results  $p < 0.05$  that means, there is a significant effect between high sodium intake on increasing blood pressure which can trigger or worsen hypertension.

Based on the results of statistical tests, there are two journals on fermentation of rice bran with a  $p\text{-value} < 0.05$  means there is a significant influence between fermentation of rice bran to decrease blood pressure in experimental animals (rats) through increased activity of ACE Inhibitors.

### Characteristics of human studies

Four references meet the inclusion criteria, all of which discuss the effect of phosphate and sodium intake on blood pressure in various regions abroad.

### Characteristics of Study In Experimental Animals (rats)

Three pieces of literature meet the inclusion criteria all discuss the results of analysis of the effect of fermented rice bran on blood pressure in various regions abroad. All studies describe interrelated factors such as the effect of rice bran fermentation on blood pressure as the role of ACE Inhibitors on blood pressure lowering.

Table 1. Results of Literature Review with Human Subjects

<i>Authors and years</i>	<i>Study design, sample, analysis</i>	<i>Outcomes of analysis factors</i>	<i>Summary of results</i>
<i>(Rossitto et al, 2020)</i>	Design: cross-sectional Sample: 766 patients of almost caucasian ethnicity Variable: High sodium intake in patients with essential hypertensi-on Analysis: Oneway ANOVA	High sodium intake (Na <sup>+</sup> ) is traditionally linked to cardiovascular risk its effect on blood pressure	On hypertensive patients that kidneys preserve water and excrete sodium excess upon high salt intake, this was associated with glomerular hyperfiltration.
<i>(Moham-mad et al, 2018)</i>	Design: Experimental (single-blind) Sample: 20 young adults Variable: Dietary Phosphate elevates BP in healthy human subject Analysis: Descriptive analysis	Getting the effect increase phosphate intake on blood pressure	Increased phosphate intake (controlled sodium) significantly increases SBP and DBP in healthy human subjects
<i>(Ozkayar et al, 2016)</i>	Design: Cross-Sectional Sample: 136 primary hypertensive patients (92 male, 44 female) Variable: dietary salt intake and ambulatory blood pressure Analysis: Chi-Square	urinary sodium correlated positively with systolic and diastolic blood pressure	might play a role in the pathogenesis of ambulatory BPV. High dietary salt intake in hypertensive patients can result in elevated blood pressure and might contribute to cardiovascular morbidity due to an increase in blood pressure.
<i>(Ravi et al, 2019)</i>	Design: a correlational study Sample: 6876 (>20 years) Variable: sodium intake, blood pressure, dietary sources of sodium Analysis: linear regression	There is an independent association between dietary sodium intake and BP.	In a sample population, the dietary intake of sodium was higher than recommendations and a predictor increases blood pressure

Table 2. Results of Literature Study Review with Animal Studies

<b>Authors and years</b>	<b>Study design, sample, analysis</b>	<b>Outcomes of analysis factors</b>	<b>Summary of results</b>
<i>(Alauddin et al, 2016)</i>	Design: True Experimental Design Sample: 18 rats (3 groups of 6 rats each and supplied 5% of FRB, Non-FRB, water (control)) Variable: fermented rice bran supplementation in hypertensive rats Analysis: SigmaPlot	Getting the effect of fermented rice bran and non-fermented rice bran supplementation on systolic and diastolic blood pressure	Chronic supplementation with 5% FRB most significantly reduced both systolic and diastolic blood pressure. FRB supplementation increase angiotensin-converting enzyme inhibitory activity.
<i>(Mizuno et al, 2016)</i>	Design: True experimental design Sample: 26 rats (13 rats 0,6% Pi and 13 rats 1,2% Pi) Variable: high dietary phosphate intake induce hypertension Analysis: unpaired t-test	Getting the difference between two types of high phosphate diet	High Pi diet 1,2% proved to increase blood pressure faster than high pi diet 0,6%.
<i>(Piotrowicz et al, 2020)</i>	Design: Pre-experimental design Sample: spontaneously hypertensive rats and normotensive Wistar Kyoto rats Variable: antioxidant, ACE inhibitory properties, and blood pressure Analysis: one-way ANOVA and two way ANOVA	Rice bran protein hydrolysate, ACE inhibitory activity, high antioxidant, decrease blood pressure	the rice bran protein hydrolysates could be an interesting source of bioactive peptides, with potential action on hypertension (decrease BP) and other related pathologies.

## DISCUSSION

### **Effect of Fermentation of Rice Bran on Blood Pressure of Animal studies (rats)**

Based on research in two journals that used experimental animals (rats), they obtained the same result that fermentation of rice bran can lower blood pressure in experimental animals (rats). Rice bran fermented with fungi and bacteria is proven to increase nutrient content, especially protein, fat, antioxidants, and fiber, increase compared to non-fermentation.<sup>7</sup>

Metabolic syndrome such as hypertension is better overcome by supplementation of rice bran that fermented due to fermentation of rice bran can increase the activity of serum inhibitor ACE (Angiotensin-Converting Enzyme) that can lower blood pressure.<sup>7</sup> It is in line with a second journal study that antioxidants in rice bran can trigger serum activity of ACE inhibitors that can lower blood pressure.<sup>16</sup> Secondary metabolites produced by rice bran are a group of natural compounds identified as potential and effective ACE inhibitors such as flavonoids, tannins, hydrolyzable, and others<sup>17</sup>. Therefore, the antihypertensive effect of flavonol compounds from the flavonoid group has been studied extensively. That results in reducing oxidative stress, inhibiting angiotensin-converting enzyme activity, increasing vascular endothelial relaxation, and regulating regulate cell signalling and gene expression.<sup>17</sup>

Antioxidants can prevent and reduce oxidative stress levels, especially on the

endothelium, because antioxidants can stimulate the production of nitric oxide which plays a role in dilating blood vessels.<sup>18</sup> The resulting nitric oxide plays a role in vasodilation. Suppose the amount of antioxidants in the body is lacking. In that case lacking, it can cause a decrease in the ability of vasodilation of blood vessels which causes an increase in peripheral resistance and decreasing in the glomerular filtration rate (GFR) and activation of the renin-angiotensin system so that blood pressure increases.<sup>18</sup>

Rice bran can lower blood pressure using experimental animals called stroke-prone spontaneously hypertensive rats (SHRSP), which are rat species that are genetically hypertensive and hyperlipidemic with the mechanism of inhibiting the action of the ACE enzyme that is responsible for increasing blood pressure.<sup>19</sup> Theoretically, the inhibition of serum ACE action is carried out by inhibiting the conversion of angiotensin I to angiotensin II.

### **The Effect of Phosphate Intake on Blood Pressure in Humans Subject**

Based on a critical assessment of seven journals. a journal discusses the effect of phosphate intake on blood pressure in healthy humans. High dietary phosphate intake has been shown to increase systolic and diastolic blood pressure. Increasing phosphate intake can increase serum phosphate levels and activate the sympathetic nervous system accelerating cardiac activity and increasing blood pressure.<sup>6</sup>

It is in line with the results of other researchers that phosphate intake that is more than recommended RDA 700 mg/day increase blood pressure significantly and can complicate the work of the kidneys. It is especially in someone who has chronic kidney failure and hypertension.<sup>15</sup>

Based on the results of the study. It shows that a diet high in phosphate intake can increase arterial blood pressure by increasing in renin.<sup>11</sup> Renin is an enzyme produced by special cells in the kidneys. The function of the renin enzyme is to increase blood pressure and is also usually checked to assess whether there is a disturbance in kidney function.<sup>20</sup>

Phosphate is an independent risk of cardiovascular disease and can increase the incidence and development of chronic nephropathy or other cardiovascular diseases. Therefore, to increase the activity of ACE inhibitors, it is necessary to have a high intake of antioxidants so that the work of ACE inhibitors can be optimal.<sup>21</sup>

### **The Effect of Phosphate Intake on Blood Pressure in Animal Studies (Rats)**

Based on a critical assessment of seven journals. There is a journal that discusses the effect of phosphate intake on blood pressure in male Wistar rats. Based on the study,<sup>15</sup> a high intake of phosphate (1.2%) could significantly increase blood pressure in Wistar rats than the phosphate intake that was only given (0.6%).

Inorganic phosphates enter into the mechanism that can cause hypertension. It starts from the activation of the sympathetic

nervous system, increased stiffness of blood vessels, impaired endothelial-dependent vasodilation, and increased absorption of Na<sup>+</sup> which can increase blood pressure.<sup>22</sup>

### **The Effect of Sodium Intake on Blood Pressure in Humans Subject**

Based on research from three journals. The results were obtained that high sodium intake can increase blood pressure in healthy humans and worsen then increase blood pressure in hypertensive patients.

Blood pressure can increase due to increased volume of plasma (body fluids) due to an excessive consumption of salt (sodium) that can cause thirst and encourage the body to drink<sup>13</sup>. It increases the blood volume in the body because the input must be the same as the expenditure (output) in the vascular system so the heart must pump more strongly with higher pressure.<sup>23</sup>

In hypertensive patients, high food intake of salt (sodium) can cause a rapid increase in blood pressure and cause cardiovascular morbidity.<sup>12</sup> Other results show that excessive sodium intake can significantly increase blood pressure, especially in smokers and people who do not consume vegetables and fruits.<sup>14</sup>

Sodium is associated with high blood pressure because high amounts of sodium can shrink the diameter of blood vessels. It causes the heart to pump harder to push the increased blood volume through increasingly narrow spaces and cause increased blood pressure.<sup>24</sup>

Theoretically, the effect of sodium intake on blood pressure occurs through an



increase in plasma volume that ends in an increase in blood pressure. Sodium is the main cation in the extracellular essential in maintaining plasma and extracellular volume, acid-base balance, and neuromuscular. High sodium intake can cause the concentration of sodium in the extracellular fluid to increase, to normalise the intracellular fluid is drawn out increasing blood volume and impacting blood pressure.<sup>10</sup>

### CONCLUSION

Based on the results of the literature study fermentation of rice bran can lower blood pressure in experimental animals (rats) by inhibiting the activity of serum ACE inhibitors. Meanwhile, excessive intake of phosphate and sodium can increase blood pressure in healthy human subjects, hypertensive patients, and animals through an increase in renin mediated by parathyroid hormone and an increase in angiotensin II. Therefore, rice bran fermentation is expected to be a natural food ingredient that can be developed to lower blood pressure naturally.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest in this literature.

### Author contribution

AA designed, did the result in analysis, and compiled the manuscripts. RA gave a study idea. EW dan RA wrote the manuscripts.

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