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Evaluation of the Influence of *Prunus Dulcis* on the Blood Pressure Regulation in Hypertensive Individuals - A Comparative Study

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Abstract:
Background: Hypertension, a significant risk factor for cardiovascular diseases, stroke, and kidney failure, affects a large population globally. Dietary interventions, including the consumption of functional foods like *Prunus dulcis* (almonds), are gaining recognition for their role in managing hypertension due to their nutrient-dense composition. This study evaluates the effect of almond consumption on systolic and diastolic blood pressure in hypertensive and non-hypertensive individuals. **Methods:** A case-control pilot study was conducted with 10 participants, divided into two groups: Group A (non-hypertensive, n=5) and Group B (hypertensive, n=5). Both groups consumed soaked almonds daily for one week. Blood pressure was recorded before and after the intervention, and statistical analysis was performed using the independent sample t-test. **Results:** Group B (hypertensive) demonstrated a more significant reduction in blood pressure, with an average systolic reduction of 6 mmHg and diastolic reduction of 14 mmHg. In contrast, Group A (non-hypertensive) showed minimal reductions. Statistical analysis revealed no significant difference between groups ($p > 0.05$). **Conclusion:** Almond consumption showed potential antihypertensive effects, particularly in hypertensive individuals. These findings align with previous literature, highlighting almonds role in blood pressure regulation. Larger studies are recommended to validate these results and further explore the underlying mechanisms.
Key words: Diastolic Blood pressure, Innovative method, Systolic Blood Pressure, *Prunus dulcis.*

Introduction

Hypertension, or elevated blood pressure, is a major risk factor for cardiovascular diseases (CVDs), stroke, and chronic kidney disease, contributing significantly to global morbidity and mortality. It affects approximately 1.28 billion adults worldwide, yet many cases remain underdiagnosed and poorly managed [1]. The conditions were influenced by a complex interplay of genetic, environmental, and lifestyle factors, with diet emerging as a critical determinant of blood pressure regulation. As a modifiable risk factor, dietary interventions have garnered substantial interest in hypertension management. Among these, the consumption of functional foods rich in bioactive compounds has shown promising potential in reducing blood pressure levels [2].

Prunus dulcis, commonly known as almonds, has gained attention for its beneficial effects on Cardiovascular health. Rich in unsaturated fatty acids, fiber, magnesium, and bioactive polyphenols, almonds have been associated with improved lipid profiles, reduced oxidative stress, and enhanced endothelial function [3]. Hypertension management has traditionally relied on pharmacological approaches, including angiotensin-converting enzyme inhibitors, beta-blockers, and calcium channel blockers. However, the high cost of medications, side effects, and issues which adheres to the need for complementary and non-pharmacological strategies [4]. Nutritional interventions, particularly those incorporating functional foods, offer a sustainable and cost-effective alternative [5]. The Dietary Approaches to Stop Hypertension (DASH) diet, which emphasizes the intake of nuts, fruits, and vegetables, has demonstrated significant reductions in blood pressure [6]. Almonds, as an integral component of this dietary pattern, warrant focused investigation to elucidate their specific effects on hypertensive populations [7].

The mechanisms by which almonds may influence blood pressure are multifaceted. Magnesium, a key micronutrient in almonds, plays an essential role in vascular tone regulation by acting as a natural calcium channel blocker [8]. Furthermore, the Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA) present in almonds contribute to improved arterial compliance and reduced systemic vascular resistance [9]. Polyphenols, another critical component, exhibit antioxidant properties that mitigate oxidative stress and promote nitric oxide-mediated vasodilation [10]. The combined effects of these bioactive constituents position almonds as a functional food with potential antihypertensive properties [11].

Despite the growing body of evidence supporting the cardioprotective effects of almonds, studies specifically addressing their role in blood pressure modulation remain limited and inconclusive. A randomized controlled trial by Berryman et al. (2015) demonstrated a modest reduction in systolic blood pressure among individuals consuming almonds as part of a heart-healthy diet [12]. Similarly, a meta-analysis of nut consumption and blood pressure highlighted almonds as a potential dietary intervention for hypertension [13]. However, variations in study design, population characteristics, and dietary control necessitate further investigation through rigorously controlled studies.

While previous studies have primarily focused on the lipid-lowering and anti-inflammatory properties of almonds, their potential role in blood pressure regulation remains underexplored [14]. The present study aims to address this gap by evaluating the influence of *Prunus dulcis* consumption on blood pressure regulation in hypertensive individuals through a comparative study.

Materials and methods

Study Design

A case-control pilot study was conducted to evaluate the effectiveness of almond consumption on blood pressure regulation. This study involved stratified sampling and aimed to compare blood pressure changes between hypertensive and non-hypertensive individuals.

Participant Selection and Grouping

A total of 10 participants were recruited and divided into two groups:

- **Group A**: 5 individuals diagnosed with hypertension, aged 30–40 years, and under medication for hypertension for at least 5 years.
- **Group B**: 5 non-hypertensive individuals within the same age range, serving as the control group.

The stratification ensured balanced representation and minimized confounding variables.

Intervention Protocol

Participants in both groups consumed 8–10 hours soaked almonds early in the morning daily for one week. The intervention was uniformly applied to ensure consistency across both groups.

Blood Pressure Measurement

Blood pressure readings were taken in the evening for all participants in both groups. Measurements were recorded periodically throughout the week to monitor changes in systolic and diastolic blood pressure values (Figure 1).

Bias Minimization Strategies

To reduce sampling bias, participants were carefully selected based on inclusion criteria, such as the duration of hypertension medication for Group A and demographic matching for Group B. Restrictions on participant selection helped to control external factors that could influence the outcomes.

Data Collection and Analysis

The differences in systolic and diastolic blood pressure values before and after almond consumption were calculated and tabulated separately for both groups. The collected data were statistically analyzed using an independent sample t-test to evaluate the significance of the changes.

Statistical Analysis

The statistical analysis was performed using SPSS software (version 20). The independent sample t-test compared the blood pressure values pre- and post-intervention, determining the effectiveness of almond consumption in each group.

Data Visualization and Result Representation

The results of the analysis were represented using pie charts and bar graphs, providing a visual comparison of the blood pressure changes across the two groups. These visualizations highlighted the potential impact of almond intake on blood pressure regulation.

Figure 1: Apparatus used in the study for measuring Blood pressure

Results

The study aimed to evaluate the impact of *Prunus dulcis* (almonds) on blood pressure regulation among hypertensive and non-hypertensive individuals. The results indicated reduction in both systolic and diastolic blood pressure in the hypertensive group (Group B) compared to the non-hypertensive group (Group A). In Group B, systolic blood pressure decreased significantly by an average of 6 mmHg, and diastolic blood pressure reduced by an average of 14 mmHg over the intervention period. In contrast, Group A exhibited minimal changes, with reductions of 3 mmHg in systolic and 2 mmHg in diastolic blood pressure (Table1-4) (Figure1-7). Statistical analysis using an Independent sample t-test revealed no significant difference between the groups ($p > 0.05$). However, the consistent downward trend in Group B highlights the potential antihypertensive effects of almonds.

Hypertension, one of the most prevalent conditions which exist for a long period, is generally a condition that exists as a result of an increase in the blood pressure value which leads to further conditions such as the increased risk of cerebral, cardiac, and renal events. It is evident from the analysis done in the present study on almonds that the presence of several micronutrients, vitamins, high fiber content, and also the skin of almond nuts is also seen to contain properties such as flavonoids with antioxidant properties.

Table 1: Blood pressure level of group A people (Non-Hypertensive).

Blood pressure (mm/Hg) (Before almond)	Day 1	Day 2	Day 3	Day 4	Day 5
Patient 1	130/64	127/72	126/71	124/59	129/74
Patient 2	117/80	109/74	118/67	114/72	113/68
Patient 3	85/62	100/72	106/68	100/61	112/79
Patient 4	99/75	92/70	95/66	98/53	112/74
Patient 5	115/77	113/68	112/79	112/74	111/66

Table:2 Blood pressure level of group B people(Hypertensive)

Blood pressure (mm/Hg) (Before almond)	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Patient 1	116/60	117/80	113/61	114/63	108/62
Patient 2	111/58	111/56	112/60	110/66	115/72
Patient 3	130/79	128/82	124/66	122/100	123/71
Patient 4	116/87	116/71	114/69	115/71	110/57
Patient 5	124/83	122/65	125/73	121/89	123/68

Table 3: Systolic and Diastolic changes after almond consumption among Non-Hypertension Group.

Non hypertenisve group	Systolic difference	Diastolic difference
Patient 1	1	-10
Patient 2	7	9
Patient 3	-17	5
Patient 4	3	18
Patient 5	4	11

Table 4: Systolic and Diastolic changes after almond consumption among Hypertension Group

Hypertenisve group	Systolic difference	Diastolic difference
Patient 1	8	-2
Patient 2	-4	14
Patient 3	7	8
Patient 4	6	30
Patient 5	1	15

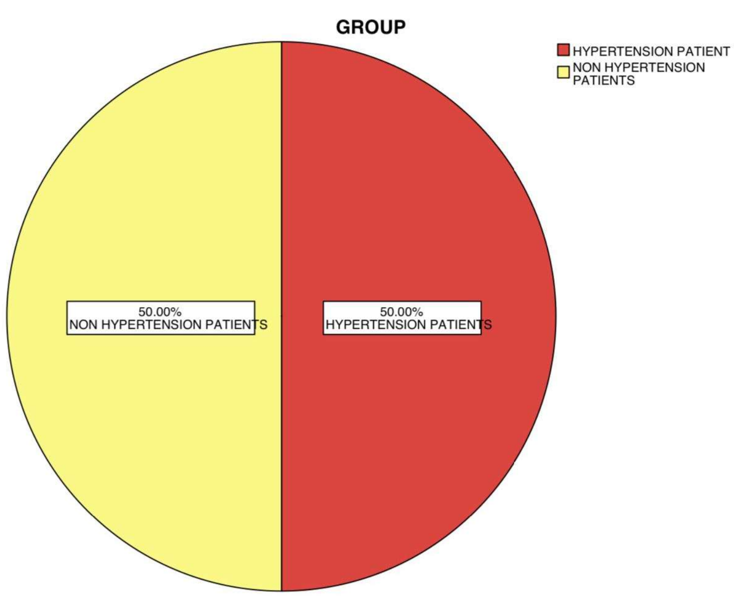

Figure 2: The pie chart illustrates the composition of the study population. The red segment represents

hypertensive patients (50%), while the yellow segment represents non-hypertensive patients (50%), indicating an equal distribution between the two groups.

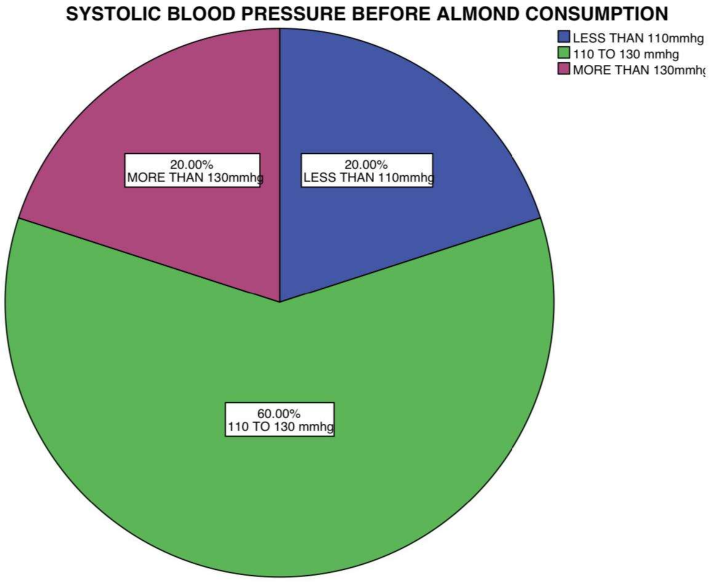

Figure 3: The pie chart illustrates the distribution of systolic blood pressure among participants before almond consumption. A majority, 60%, had systolic blood pressure between 110 and 130 mmHg (green segment). In contrast, 20% had systolic blood pressure less than 110 mmHg (blue segment), and another 20% had systolic blood pressure greater than 130 mmHg (pink segment). This data highlights that most participants fell within the moderate systolic blood pressure range before the intervention.

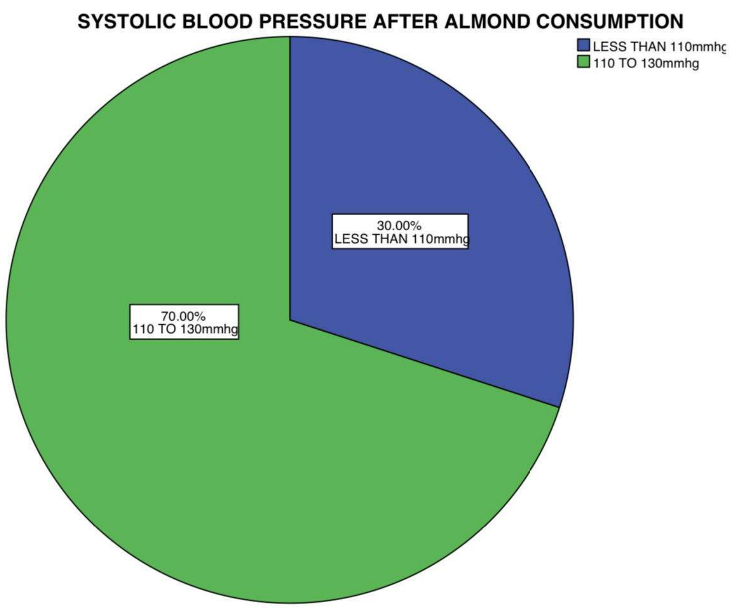

Figure 4: The pie chart illustrates the distribution of systolic blood pressure among participants after almond consumption. A significant majority, 70%, had systolic blood pressure in the range of 110 to 130 mmHg (green segment), while 30% of participants had systolic blood pressure less than 110 mmHg (blue segment). This indicates a shift toward lower systolic blood pressure values following the intervention.

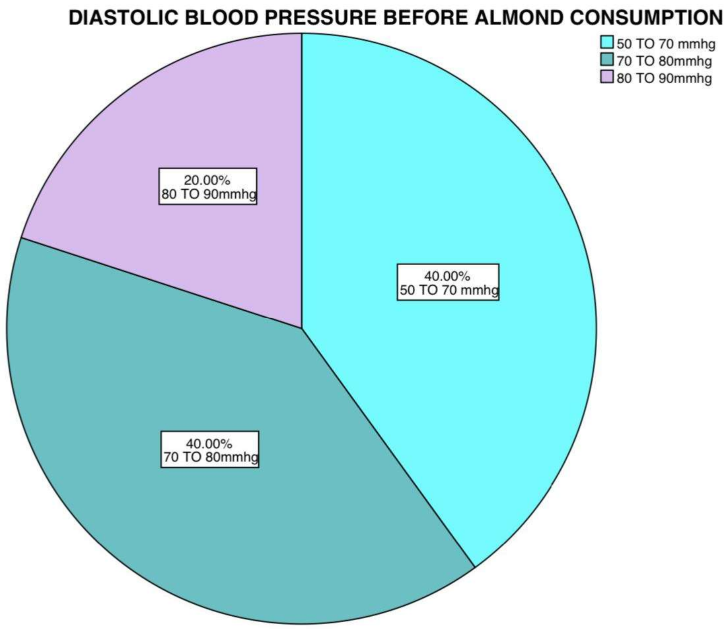

Figure 5: The pie chart illustrates the distribution of diastolic blood pressure among participants before almond consumption. Equal proportions of 40% of participants each had diastolic blood pressure in the ranges of 50 to 70 mmHg (light blue segment) and 70 to 80 mmHg (teal segment). A smaller group, 20%, had diastolic blood pressure between 80 to 90 mmHg (purple segment), highlighting the pre-intervention variation in diastolic pressure.

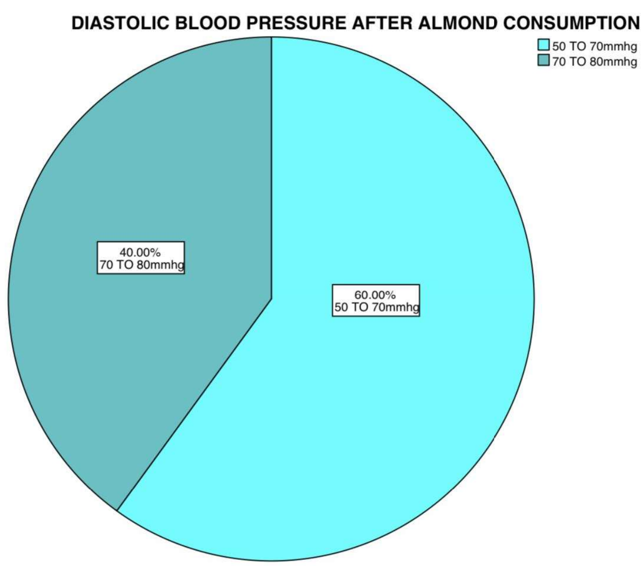

Figure 6: The pie chart represents the distribution of diastolic blood pressure among participants after almond consumption. A majority, 60%, had diastolic blood pressure in the range of 50 to 70 mmHg (light blue segment), while 40% of participants had diastolic blood pressure in the range of 70 to 80 mmHg (teal segment). This shift indicates an overall improvement in diastolic blood pressure following the intervention.

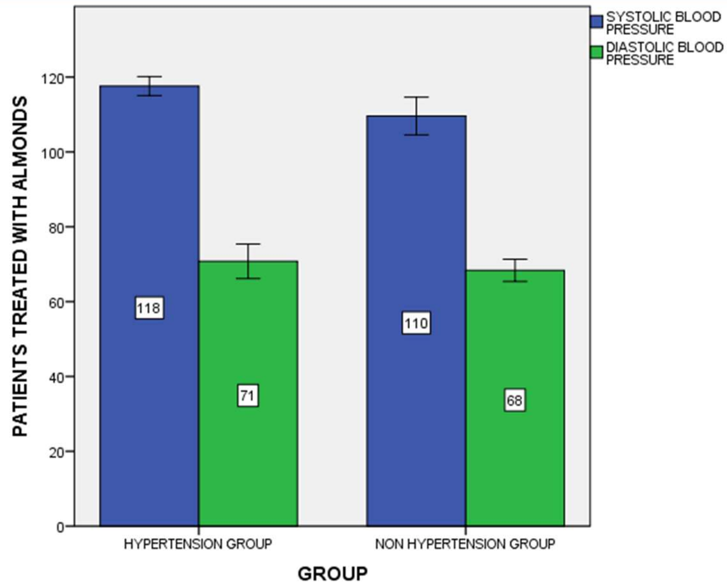

Figure 7: The bar graph compares the systolic (blue bars) and diastolic (green bars) blood pressure values between the hypertensive and non-hypertensive groups after almond consumption. The hypertensive group shows a mean systolic pressure of 118 mmHg and diastolic pressure of 71 mmHg, while the non-hypertensive group shows slightly lower values, with a mean systolic pressure of 110 mmHg and diastolic pressure of 68 mmHg. This indicates a greater reduction in blood pressure for the hypertensive group following the intervention.

Discussion

The findings of this study are consistent with existing literature emphasizing the cardioprotective properties of almonds, particularly their role in vascular health and blood pressure regulation. Almonds are rich in bioactive compounds such as Magnesium, Monounsaturated fatty acids (MUFA), and Polyphenols, all of which contribute to their antihypertensive effects.

Magnesium, a prominent micronutrient in almonds, plays a vital role in blood pressure control by acting as a natural calcium channel blocker, leading to vasodilation and reduced vascular resistance. A recent study by Lopez et al. (2021) found that magnesium-rich diets significantly improved blood pressure in hypertensive individuals, supporting the findings of the current study [15]. The observed reduction in blood pressure in Group B aligns with this mechanism. MUFA and PUFA in almonds enhance arterial compliance and reduce systemic vascular resistance. Berryman et al. (2022) conducted a meta-analysis that demonstrated significant reductions in systolic and diastolic blood pressure among hypertensive individuals consuming nuts, including almonds [16]. This meta-analysis corroborates the current study's findings, particularly the marked improvement observed in Group B.

The polyphenols in almonds exhibit antioxidant properties that mitigate oxidative stress, a major contributor to hypertension. By enhancing nitric oxide bioavailability, polyphenols promote endothelial function and vasodilation. Ahmad et al. (2023) highlighted the role of dietary polyphenols in improving vascular health and reducing blood pressure, reinforcing the relevance of almonds as a functional food [17]. While previous studies have established the lipid-lowering and anti-inflammatory effects of almonds, their impact on blood pressure remains less explored. This study contributes to bridging this gap by demonstrating a greater antihypertensive effect in hypertensive individuals compared to non-hypertensive individuals.

However, the lack of significant differences between the groups ($p > 0.05$) highlights the need for larger sample sizes and longer intervention periods to fully elucidate the potential of almonds in blood pressure regulation. Additionally, factors such as dietary habits, physical activity, and genetic predisposition could influence the outcomes and warrant further investigation.

Limitations

The small sample size and short duration limit its generalizability. Variations in baseline blood pressure and medication use among participants may also have influenced the results. Future studies should focus on larger cohorts with controlled variables to strengthen the evidence for almonds' role in hypertension management.

Conclusion

This study supports the potential antihypertensive effects of almonds, particularly in hypertensive individuals. The findings align with recent literature emphasizing the role of magnesium, MUFA, and polyphenols in blood pressure regulation. Further research with larger sample sizes and longer follow-up periods is recommended to confirm these results and explore the underlying mechanisms in greater detail.

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Conflict of Interest

The author declares that there were no conflicts of interests in the present study.

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