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# Analysing the Parallel Scalability of Mechanical Nano-computers Through Interconnection Network Evaluators for Pharmaceutical Applications

Eesha Tariq[1], AbdurRehman Haroon[1*], Danyal Farhat[1]

## Abstract

This paper explores the potential of mechanical nano-machines for computation by evaluating its parallelisation power through static interconnection network evaluations. It investigates the mechanical nano-machine model as a 2-Dimensional mesh to analyse factors like diameter, bisection width, arc connectivity, and cost. The research suggests that around 448 nanogears per machine offers an ideal balance between minimizing diameter and bisection width while maximizing connectivity, proving that a mechanical nano-computer is indeed parallelisable. This highlights the potential scalability of mechanical nano-computers, showcasing their potential in pharmaceutical applications.

**Keywords:** Nano-computers, Interconnection network evaluation, Pharmaceutical applications, Nanotechnology.

## 1. Introduction

Since its conceptual birth in the 1950s, nanotechnology has come a long way. The modelling and development of nano-machines have resulted in a significant shift in the way we view nano-technology. At present, science recognizes various types of nano-machines (machines that use components of a nano-scale, or a scale of one billionth of a meter, or $10^{-9}$ meters, and perform various computational tasks as machines do) which have all been documented as a result of relentless research in the nano-realm.

One of such machines are the Molecular Nano-machines (or nano-technology), which come under the umbrella of Mechanical Nano-computers. Introduced by K. Eric Drexler in 1987 (Drexler et al., 1987), the broader vision of Molecular Nano-technology (MNT) that consisted of the brand new 'mechanical nanomachines' largely served as a foundation for a new nano-technological model. At a molecular level, nano-machines, being a class of machines that are so small in scale yet can respond to inducements with mechanical movements (that of switches, gears, and motors), find their potential way into various fields of modern research and design of mechanical computing devices, while still being in the process of development and improvement (Wang et al., 2009). The Drexler model comprises of rods and bumps with tiny mobile components called nanogears that encode information. As a whole, a molecular or mechanical nano-machine was proposed to resemble a graph of strongly connected components, or a nano-scale network model.

Mechanical machines, in summary, replace electronic components with mechanical work to perform computations. Combining this with nano-machines, we aim to understand the mechanical computation power of nano-

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computers at various levels. This paper this discusses the behaviour of mechanical nano-machines as a network model, applying mathematical evaluation equations to determine the cost, connectivity, bisection, and diameter of these mechanical nano-networks. This will provide us with useful data that can help in calculating the computing power as parallel entities, cost, and optimisation of mechanical nano-computers, finding their worth in the future of nano-science and parallel computing. Finally the scalability (increasing components while obtaining viable results) of the mechanical nano-machines can also be assessed.

The paper is organised as follows: Related Work in Section II gives insight into the root of this research, the Research Methodology discussing the inferences on these mechanical nano-machines, while sections IV, V and VI confer the Implementation Details, Results Inferred, and Conclusion along with Future Implementations, respectively.

## 2. Related Work

Although the research and development of mechanical computing nano-machines have been limited and relatively new, the vision of Drexler to create nano-machines that can perform complex computation has been closer than ever. The computation power of mechanical nano-machines has exponentially increased on paper as the optimization of gates, levers, gears, switches, and springs was prioritized, with its usability and innovation surpassing boundaries that were inconceivable in 1986, when the research for nanotechnology and nano-machines was still in its nascent stages. At present, the Moore's law bottle neck and other such obstacles have been overcome by scientific advancement and configuration of nano-mechanical components (Way et al., 2010).

### 2.1. Structure of Drexler's Model

Drexler's proposed model consisted of node-like nanogears that perform the primary task of data and information encoding. These gears would roll around the others to create the calculation and data transfer among different nano-machines. The rods would intersect and connect the nodes within that nano-machine together. The calculation that takes place through rolling and ticking of the nanogears is similar to the model of a Pascaline computational device. If looked at it in another perspective, when flattened, these nano-machines form a mesh of gears and rods (Buell et al., 1973). Therefore, the mechanical nano-computer model introduced by Drexler can be assumed to be a 2-Dimensional mesh with wraparound for the sake of mathematical calculations. Farhat et. al. introduced a mathematical model to analyse the connectivity and its shape in a 2-Dimensional mesh with wraparound and without wraparound (Buell et al., 1973).
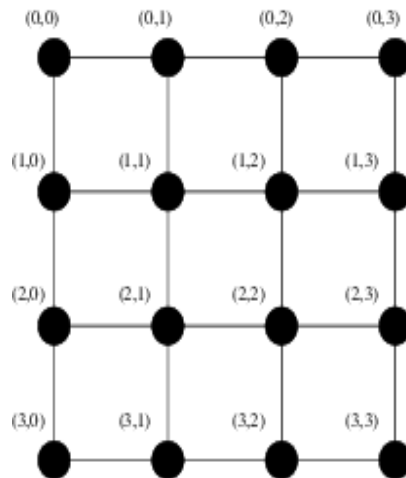


**Figure 1** The 2-Dimensional mesh without wraparound for n ∈ {4}.
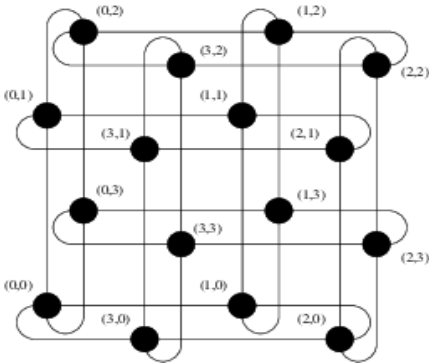
**Figure 2** The 2-Dimensional mesh with wraparound for n ∈ {4}.

## 2.2. Limitations of the Drexler Model

The Drexler-Smalley debate argued the material limitations of the Drexler MNT model (Johnson et al., 2007). Smalley questioned the feasibility of constructing assemblers that work on a molecular level. However, the scalability potential of the mechanical nano-computers still appear remarkable at a conceptual level.

This model of a n-dimensional 2-Dimensional mesh with and without wraparound is essential to discuss the computation, connectivity, cost, bisection width, and other properties of a molecular mechanical nano-machine. Robert H. Blick et al. (2007) proposed that nano-machines can be improved with the introduction of mechanical computing into the architecture by using terms such as mechanical-resonance and non-linear modification of resonance frequency (Blick et al., 2007). They promise that nanomechanical computing offers a promising new approach to computing, with potential applications in fields like sensing, signal processing, and cryptography, but the scalability of such nano-machines is limited to just the mathematical knowledge of man.

## 3. Research Methodology

Mechanical nano-computing, or Drexler's Molecular Nano-technology (MNT) is a new and untreaded matter in the field of nano research. The pioneer research is not forty years old yet, but the potential mechanical nano-computers serve is remarkable. Mechanical nano-computers promise to be energy efficient by utilizing mechanical parts and parameters to perform tasks. Moreover, they are presumed to be scalable by detaching and attaching more components or changing the rods. While the earliest rod-sliding model has been deemed unworkable as per the Drexler–Smalley debate (Smalley anticipated a "fat fingers" problem: the apparatus placing the atoms would be too large to fit in the tiny space available), the primitive model still withholds its simplicity and potential, especially in the terms of scalability.

The model, that looks like a network of nodes and connections, is indeed a place for exchange of data and storage of properties, as well as computation through mechanical movements. To analyse them, the proposed 2-

**Table 1** Evaluation of static interconnection networks

| Network | Diameter | Bisection Width | Arc Connectivity | Cost |
|---|---|---|---|---|
| Completely connected | 1 | $\dfrac{p^2}{4}$ | $p-1$ | $\dfrac{p(p-1)}{2}$ |
| Star | 2 | 1 | 1 | $p-1$ |
| Complete Binary Tree | $2\log\left(\dfrac{p+1}{2}\right)$ | 1 | 1 | $p-1$ |
| Linear array | $p-1$ | 1 | 1 | $p-1$ |
| 2-D Mesh without Wraparound | $2(\sqrt{p}-1)$ | $\sqrt{p}$ | 4 | $2(p-\sqrt{p})$ |
| 2-D Mesh with Wraparound | $2\left\lfloor\dfrac{\sqrt{p}}{2}\right\rfloor$ | $2(\sqrt{p})$ | 4 | $2p$ |
| Hypercube | $logp$ | $\dfrac{p}{2}$ | $logp$ | $\dfrac{plogp}{2}$ |
| Wraparound K-ary D-cube | $d\left\lfloor\dfrac{k}{2}\right\rfloor$ | $2k^{d-1}$ | $2d$ | $dp$ |

**Table 2** Evaluation of static 2-dimensional mesh without wraparound network

| Network | Diameter | Bisection Width | Arc Connectivity | Cost |
|---|---|---|---|---|
| 2-D Mesh without Wraparound | $2(\sqrt{p}-1)$ | $\sqrt{p}$ | 4 | $2(p-\sqrt{p})$ |

**Table 3** Evaluation of static 2-dimensional mesh with wraparound network

| Network | Diameter | Bisection Width | Arc Connectivity | Cost |
|---|---|---|---|---|
| 2-D Mesh with Wraparound | $2\left\lfloor\dfrac{\sqrt{p}}{2}\right\rfloor$ | $2(\sqrt{p})$ | 4 | $2p$ |

Dimensional mesh with and without wraparound formulas are to be used in order to:

*1) Maximise the arc connectivity:* The arc connectivity is a measurement of the minimum number of edges required to disconnect two nodes in a network. Maximising this parameter can enhance the fault tolerance and robustness of the mechanical nano-machine's structure.

*2) Minimise the diameter:* The diameter of a network of nodes and connections represents the maximum distance between any two nodes in the 2-Dimensional mesh with and without

*3)* wraparound. A smaller diameter means shorter communication paths and faster data transfer. In a mechanical nano-computer model, the data transfer is required to be quick and efficient, therefore it is necessary to find a point where the diameter of the network is minimised.

*4) Maximise the cost:* Here, cost refers to the number of edges or connections in the 2-Dimensional mesh with and without wraparound that are related to one another. A higher cost indicates more connections, which can lead to better network performance and reliability. As with arc connectivity, a more interconnected graph can lead to better network performance, and therefore, more robustness in the structure.

*5) Minimise the bisection width:* The bisection width represents the minimum number of edges that need to be removed to divide the 2-Dimensional mesh with and without wraparound into two disconnected parts. This, by definition, prompts the independence of the connected nano-computers, and their ability to perform freely. A smaller

*6)* bisection width indicates better connectivity and resilience.

The aim of this research is to calculate results of the different values of the variables M (number of horizontally connected components in a 2-Dimensional mesh with and without wraparound) and N (number of vertically connected components in a 2-Dimensional mesh with and without wraparound). These can also be used to evaluate the parallelisation power of these mechanical nano-computers (as they are theorized to work together, at the same time). Testing the limitations of a mechanical nano-machine's scalable parts is, thus, the final product of this research paper.

## 4. Paralleisation and Interconnection Network Evaluation of Mechanical Nano-Computers

Evaluating the proposed methodologies is essential to determine the longevity of the proposed nanomechanical models for mechanical computation. We must first consider the structure of a proposed nanomechanical computer.
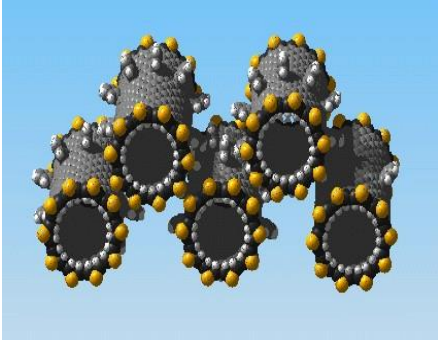
**Figure 3** A nano-Pascaline model.
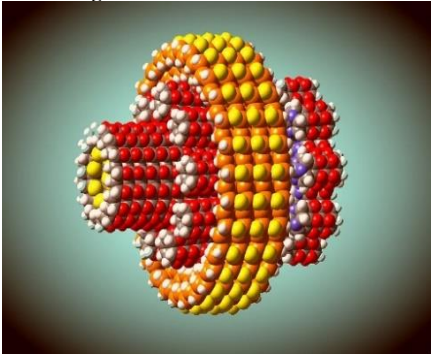


**Figure 4** A Nanob.

Assuming a nanomechanical computer (or a mechanical nano-computer) is in the form of a 2-Dimensional mesh when flattened, with or without wraparound, is reasonable for this research. Referring the Encyclopedia of Parallel Computing by David Padua (Padua et al., 2011), we can extract the following table (Table I) for the evaluation of static interconnection networks. Calculations are a necessary segment of this research paper.

We run a python code that calculates the four evaluation factors above to determine the trends in the values for M and N. Ranging these values from 1 to 1000, we compute:

We evaluated the results in terms of graphs and create a table of a few significant results for some values of M and N.

**5. Results**

After running a code to plot the diameter, bisection width, arc connectivity, and cost of a 2-Dimensional mesh with wraparound shaped mechanical nano-machine model using

van Meek et. al research (van Beek et al. 1999).

**5.1. Arc Connectivity**

We know from the evaluation formula that the arc connectivity of a 2-Dimensional remains constant with or without wraparound. Therefore, the graphs for the arc connectivity remain constant and uniform at $y = 4 \ \forall \ x \in \{1 - 1000\}$ (here $x = M, N$). The graphs for the arc connectivity of 2-Dimensional mesh with and without wraparound are given below.
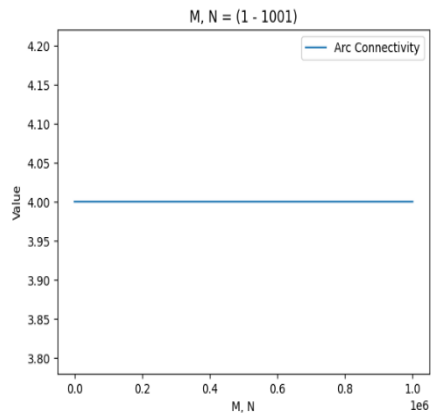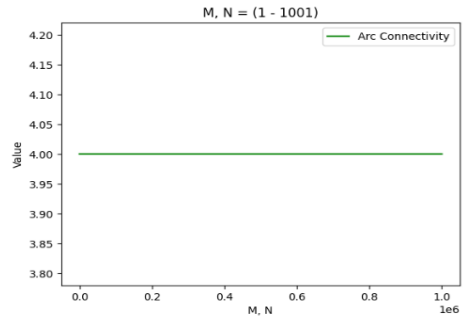




**Figure 5** The graph for the arc connectivity of a 2-Dimensional mesh with no wraparound & The graph for the arc connectivity of a 2-Dimensional mesh with wraparound.

This shows that regardless of the number of nanogears or nodes in the mechanical nano-computer, the minimum number of edges required to disconnect two nodes (or nanogears) in a model is 4.

On the other hand, the bisection width of the two increase sharply until around $0.2 * 1e6$ nanogears (Fig. 7.), after which

they begin to flatten out. A similar trend is observed with the diameter of the nano-computer (Fig. 8.). From this we can find out that the best values of both of the components is before the graph starts flattening. This implies that the ideal values of M and N are around 448.
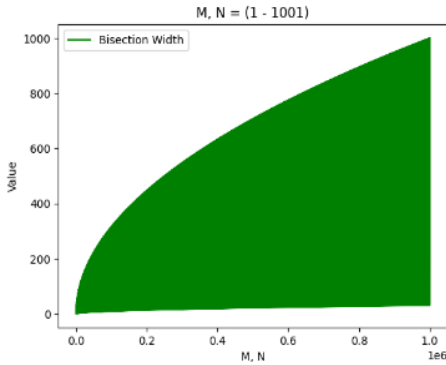
**(a)**
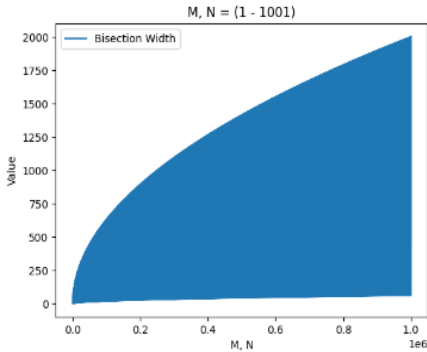
**(b)**

**Figure 6** The graph for the bisection widths of a (a) 2-Dimensional mesh without wraparound and (b) 2-Dimensional mesh with wraparound for the values of M and N $\in \{1 - 1000\}$.
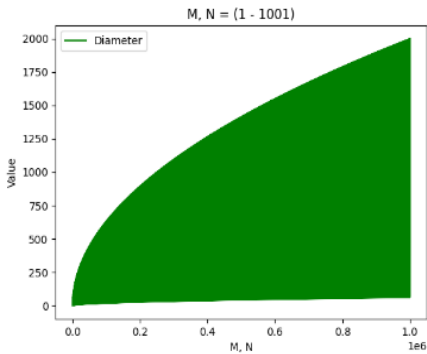
**(a)**
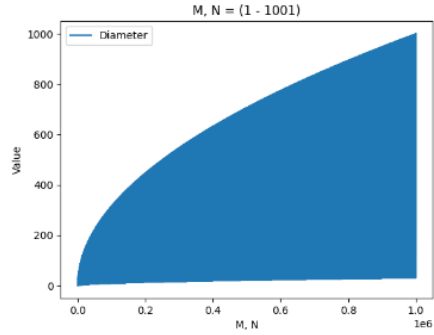
**(b)**

**Figure 7** The graph for the diameters of a (a) 2-Dimensional mesh without wraparound and (b) 2-Dimensional mesh with wraparound for the values of M and N $\in \{1 - 1000\}$.

Finally, the cost of both 2-Dimensional wraparound and no wraparound mesh create a steep, straight slope that show increase in cost as M x N increase in value, reaching a maximum of approximately 2000 in both the cases. We can visualise this better if we fix the value of N = 2, imaging this to be a 2-Dimensional mesh with no intermediary nodes, just a rectangular border.
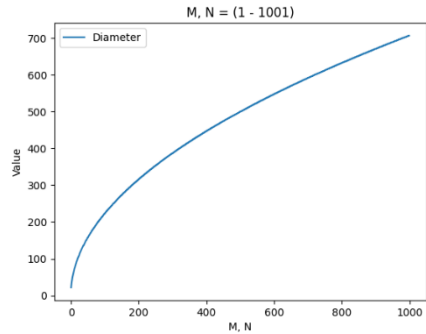
**Figure 8** The graph for the diameters of a 2-Dimensional mesh (with and without wraparound for M ranging from 1 to 1000, and N = 2.

Keeping all of these in mind, we can conclude that the number of nanogears (nodes) in a single mechanical nano-computer can ideally be around 448, as we are required to minimise both the diameter and the bisection width. Having more than 400 nanogears to store and encode data in a singular mechanical nano-machine is remarkable. It nods at the scalability power of the MNT and mechanical nano-machine.

## 6. Conclusion (Future Directions)

The scalability of mechanical nano-computers based on the Drexler MNT model of a mechanical nano-machine with nanogears (nodes) and rods (connections) can be scaled up to 448 individual nanogears. These nanogears provide a platform to encode information and act as a 'memory' for the nano-machine. Further, these nanogears alight with the nano-gears of other nano-machine components to perform the mechanical calculations, in a Pascaline method.

The mechanical calculations of a nano-computer are theorized to be far more efficient in terms of energy consumption as compared to the electronic nano-computer. The scalability of mechanical nano-computers is also hypothesized to be remarkable. These achievements make the mechanical nano-machine especially useful in the field of medicine. Nanomedicine and nano delivery systems (for drug transmissions and transfer) are a new but rapidly developing science. These consist of the carriage of nanoscale materials through a body's blood stream and fluids, often the drugs that are to participate in drug-drug transmissions. Nanotechnology offers multiple benefits in treating chronic human diseases by site-specific, and target-oriented delivery of precise medicines in precise locations. Replacing the electronic components of these nano-tech devices with nanogears (with encoded information about the drug and the location of the organ affected) of a nano-mechanical device can help tremendously. The scalability of a mechanical nano-machine further assists in storing more information about the drug delivery system, and creating faster transfer of drugs to the specified target.

Mechanical nano-computers can potentially be improved with automation systems, distribution of data amongst nanogears or nodes, and assist in nano-robotics. Cochlear implants can be automated through specially designed mechanical nano-robots for surgical environments. The ability to re-join damaged nerves to improve optical conditions at a molecular level will be streamlined with the introduction of like-sized nano-robots that are both scalable and efficient.

The applications of mechanical nano-machines, especially as mechanical nano-robots. For future work, we would like to limit the environmental conditions of these hypothetical mechanical nano-machines to bio-atmospheres, such as the human body, and mathematically observe their behaviours. We hope to contribute to the rapidly growing research in the modelling of mechanical nano-machines, especially in medical fields.

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# Nutritional and Sensory Evaluation of Bread Fortified with Defatted Chia Flour

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## Abstract

Nutritional awareness among consumer is increasing along with their life styles changes day by day. Bread is the most popular product that can be enriched with various seeds *i.e.* chia seeds that are known for their high nutritional value. Defatted chia seeds serve as excellent protein source and often used to boost the nutritional content of bread. In this study, bread was fortified with 2%, 4%, and 6% defatted chia flour, which significantly improved its overall nutritional profile. Addition of defatted chia flour up to 6% is acceptable to consumer. Results showed that color of defatted chia flour bread was slightly darker than normal bread. Addition of defatted chia flour in bread made it easily breakable with firmer texture. Texture of chia bread was less chewy and sticky as compared to normal wheat bread. The addition of defatted chia flour increased protein content to $12.18\pm0.02\%$, $14.75\pm0.06\%$, and $16.94\pm0.04\%$ in $T_1$, $T_2$, and $T_3$ as compared to simple wheat bread *i.e.* $10.85\pm0.08\%$. Likewise, total phenolic contents increased to $2.70\pm0.23\%$, $33.63\pm0.27\%$, and $4.20\pm0.13\%$ in $T_1$, $T_2$, and $T_3$ of defatted chia bread from $1.45\pm0.05\%$ in simple wheat bread. Overall, addition of defatted chia seed powder enhanced the nutritive value of bread remarkably.

## 1. Introduction

Malnutrition remains a critical global issue, especially among children during their early development stages when their brains are still undergoing rapid growth and development. Deficiencies in essential nutrients during these stages can significantly impair memory, cognitive development and behavior with long-term consequences. Studies have shown that inadequate nutrition during pregnancy and early childhood correlates with reduced cognitive and memory function, especially in resource-constrained populations. People believe that the growth of the brain and intelligence rely on three important things: genes you are born with, a good environment to learn in, and eating the right kinds of foods (Adamczyk *et al*, 2021).

Food scientists are continuously working to develop optimal food formulations that cater to consumers' growing demand for natural, nutritious, and functional foods. Bread, a widely consumed staple, is providing a

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convenient and versatile source of nutrition. One approach to enhancing its nutritional profile is by fortifying it with nutrient-dense ingredients such as seeds (Adamczyk *et al.,* 2021). However, for a healthier lifestyle, it is recommended to include whole grain bread in the daily diet due to its higher fibre and nutrient content (Sayed-Ahmad *et al.,* 2018).

The rising demand for healthy and nutritious foods among consumers has pushed the food industry to explore and harness its resources to develop functional ingredients. Recently, wheat bread and other bakery products have been enriched with innovative ingredients to improve their nutritional value (Adamczyk *et al.,* 2021). Many studies have shown that making simple changes to our diet, such as including more whole grains, seeds, high-fiber foods, and omega-3 fatty acids, can help reduce cholesterol and lower the risk of serious conditions like coronary artery disease (Iglesias *et al.,* 2013). This emphasizes how powerful food choices can be in shaping our overall health.

Chia seeds *(Salvia hispanica)*, part of the *Lamiaceae* family, have been used as a nutritional staple for centuries, especially in the diets of ancient civilizations in Central and South America. What makes chia special isn't just its historical roots but its incredible nutritional profile, which has made it a modern-day superfood. In today's world, chia seeds have become highly sought after, not only for rich omega-3 content but also for high fiber, protein, and antioxidant levels (Madruga *et al.,* 2020). Chia has found its way into a variety of foods, from snacks like cookies and breakfast cereals to health supplements, reflecting its versatility.

Chia seeds offer a broad range of essential nutrients *i.e.* around 30% oil, with high concentration of alpha-linolenic acid, 20-26% protein, 3-5% ash, 25-40% carbohydrates, and a substantial amount of dietary fiber (17-29%), which is essential for maintaining digestive health

and reducing cholesterol and blood sugar levels (Rendón-Villalobos *et al.,* 2012). Moreover, after oil extraction, chia seed meals still retain considerable nutritional value. The remaining fiber content is about 19-23%, while protein levels range from 34-40%, along with a rich presence of antioxidants (Jiménez *et al.,* 2019).

Incorporating chia flour into bread recipes not only improves its nutrient density but also offers potential health benefits. Regular consumption of chia-enriched bread may support cardiovascular health, promote better digestion, and help maintain healthy cholesterol and blood sugar levels. This research explores the effects of defatted chia flour (2%, 4%, and 6%) to bread, examining how it enhances the overall nutritional value without compromising its sensory qualities. By integrating chia seeds into bread, we aim to create a product that not only meets consumer demands for healthier options but also contributes to improve public health. The purpose of this study was to assess the effects of adding defatted chia flour to bread in order to boost its nutritional profile.

## 2. Materials and Methods

The present study was conducted at Postgraduate Research Laboratory of TIMES Institute Multan undertaking a Nutritional and Sensory Evaluation of Wheat-based Bread Fortified with Defatted Chia Flour. The following approaches and processes are described in detail:

### 2.1. Procurement of raw materials

Chia seeds (*Salvia hispanica L.*) and other ingredients (wheat flour, sugar, salt, and dry yeast) were acquired from a local store in Multan. The chemicals & standards including those used in proximate and phenolic analyses were bought from Merck (Merck KGaA, Darmstadt, Germany) and Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan).

**Table 1** Composite flour treatments

| Treatments | Wheat flour (%) | Chia flour (defatted %) |
|---|---|---|
| $T_0$ | 100 | 0 |
| $T_1$ | 98 | 2 |
| $T_2$ | 96 | 4 |
| $T_3$ | 94 | 6 |

## 2.2. Preparation of raw material

The chia seeds were cleaned thoroughly prior to grinding into fine powder that was used for further analyses.

## 2.3. Proximate analysis

Chia seeds and wheat flour were initially analyzed for proximate composition including moisture, crude fat, crude protein, ash crude fiber and nitrogen free extract (NFE) (AACC, 2000; AOAC, 2006).

## 2.4. Measurement of Total Phenolic Content

The total phenolic content (TPC) of chia seeds was assessed spectrophotometrically by applying a modified Folin-Ciocalteu method (Sayed-Ahmad *et al.,* 2018)

## 2.5. Defatting of chia seeds

Ground chia seeds were defatted by extracting oil using conventional solvent (hexane) in a soxtec system (Model: H-2 1045 Extraction Unit, Hoganas, Sweden) (AOAC, 2006). The defatted chia seeds were dried prior to storage for further use.

## 2.6. Composite flour development

Defatted chia seeds flour was used to replace wheat flour to prepare different blends of composite flour with substitution levels of 2%, 4% and 6% as mentioned in Table 1.

## 2.7. Pan bread processing

The straight dough process was performed in pan bread preparation according to the method described by El Hadidy (2020). The materials were: 100 g Wheat flour, 1.5 g instant active dry yeast, 2.0 g sugar, 2.0 g salt, 3.0 g shortening and water. Formulas containing defatted chia flour as partially substitute for Wheat flour at different extents (0, 2, 4 and 6%) were placed in a mixing bowl to mix for 6 minutes at $28 \pm 2.0°C$. The formulated

dough was rounded manually by folding for 20 times and then left to rest for 10 minutes. The prepared dough was placed in baking pans and left in a cabinet for proofing at $30 \pm 0.5$ °C and 85% relative humidity for 80 minutes. Furthermore, the dough was baked at 250 °C for 20 minutes. Finally, the baked bread was cooled at room temperature $(25 \pm 2.0$ °C) for 60 minutes and then packed in polyethylene bags for further analyses.

## 2.8. Chemical characteristics
## 2.8.1. Proximate Analysis

The levels of ash, minerals, crude protein, fat, fiber, moisture were analyzed using standard method (AOAC, 2006), and nitrogen-free extract was analyzed using (AACC, 2000) method.

## 2.8.2. Measurement of Total Phenolic Content

The total phenolic content (TPC) was assessed spectrophotometrically by applying a modified Folin-Ciocalteu method (Sayed-Ahmad *et al.,* 2018). Phenolic compounds were first extracted using a methanol-water mixture, followed by filtration to remove solid residues. A calibration curve was prepared using gallic acid as a standard. For the reaction, 1 mL of the sample extract was mixed with 5 mL of 10-fold diluted Folin-Ciocalteu reagent and allowed to react for 3 minutes. Then, 4 mL of 7.5% sodium carbonate solution was added, and the mixture was incubated at room temperature for 2 hours in the dark. Absorbance was measured at 765 nm using a UV-Vis spectrophotometer, and TPC was expressed as milligrams of gallic acid equivalents per gram of sample (mg GAE/g).

**Table 2** Proximate Composition (%) and TPC of Raw Materials (100g)

| Parameter | Wheat Flour | Defatted Chia Flour |
|---|---|---|
| **Moisture content** | 12.5±0.06 | 7.6±0.05 |
| **Crude Protein** | 11.7±0.31 | 26.5±0.44 |
| **Crude fat** | 1.5±0.12 | 32.8±0.13 |
| **Crude fibre** | 3.10±0.13 | 23.5±0.94 |
| **Ash** | 0.45±0.05 | 4.10±0.08 |
| **NFE** | 70.75±0.14 | 5.5±0.12 |
| **TPC (mg GAE/g d.m.)** | 0.65±0.06 | 5.70±0.26 |

## 2.9. Physical characteristics

### 2.9.1. Color analysis

The crumb color of the bread was assessed using the L*, a*, and b* color values, which are standard for evaluating the appearance of food products. The color measurements were taken using a HunterLab MiniScan XE Plus colorimeter (Sayed-Ahmad *et al.,* 2018). While the color difference was calculated using the following formula:

$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

### 2.9.2. Textural profile

The texture of bread was analyzed with the assistance of the TA.XT2i Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK). We followed the Standard Procedure for Firmness and Elasticity from the American Institute of Baking (located in Manhattan, KS) as elaborated by Shearer and Davies (2005). This texture analyzer is automatic equipment with software attached that shows values of texture parameters (Sayed-ahmad *et al*, 2018).

### 2.9.3. Volume

The bread's volume was determined using the displacement method, where the volume of displaced seeds indicated the bread's size (AACC, 2000). A container of known volume was partially filled with small seeds, and the initial seed level was recorded. The bread sample was carefully placed into the container, displacing the seeds to a new level. The volume of the displaced seeds was measured as the difference between the initial and final seed levels. Care was taken to minimize gaps or voids by gently tapping the container during measurement. Bread volume was expressed in cubic centimeters (cm³).

### 2.9.4. Sensory Evaluation

The sensory characteristics were assessed using 9-point hedonic scale (Meilgaard *et al.,* 2007). The training was done to teach 9 people (aged 25 to 45) regarding method of evaluation using their senses. A scale from 9 (really liked) to 1 (really disliked) was used for individual rating. The sensory assessment of the bread samples was done in the Sensory Evaluation Lab of TIMES Institute Multan. During the session, four pieces of bread from each group were given to the panelists. The members were requested to evaluate according to their perceptions and opinions.

## 2.10. Statistical analysis

The obtained data was statistically analyzed via Statistical Package (Costat-2003, CoHort, v 6.1.). Moreover, the analysis of variance (ANOVA) was employed to determine the level of significance through completely randomized design (CRD) as described by Montgomery (2017).

# 3. Results and Discussion

Adding chia flour to bakery products significantly enhanced their nutritional profile, particularly in terms . It has now been established that chia have great potential as ingredient for making healthy food items like cookies, bars, bread etc. Huerta *et al.* showed that substituting wheat flour with chia flour not only reduced saturated fat content but also increased polyunsaturated fats, particularly omega-3 fatty acids, thus

**Table 3** Chemical composition (%) of bread containing defatted chia flour

| Parameters | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|
| Moisture content | 35.80±0.53 | 33.55±0.31 | 32.75±0.18 | 31.50±0.15 |
| Crude protein | 10.85±0.08[d] | 12.18±0.02[c] | 14.75±0.06[b] | 16.94±0.04[a] |
| Crude fat | 2.10±0.06[a] | 1.82±0.03[b] | 1.30±0.02[c] | 0.50±0.05[d] |
| Crude fiber | 3.60±0.12[d] | 5.79±0.13[c] | 6.60±0.14[b] | 7.17±0.15[a] |
| Ash | 0.86±0.10[d] | 1.02±0.03[c] | 1.25±0.04[b] | 1.72±0.03[a] |
| NFE | 46.79±0.14[a] | 45.64±0.12[b] | 43.35±0.09[c] | 42.17±0.12[d] |
| TPC (mg GAE/g d.m.) | 1.45±0.05[d] | 2.70±0.23[c] | 3.63±0.27[b] | 4.20±0.13[a] |

*T0 indicates the control group, and T1, T2, and T3 represent samples with 2%, 4%, and 6% defatted chia flour, respectively. Results are shown as mean ± SD; letters mark significant differences at 0.05 level.

enhancing the overall nutritional quality of gluten-free bread formulations.

### 3.1. Proximate composition and TPC of raw materials

The Table 2 provides information on the proximate composition and Total Phenolic Content (TPC) of the raw material under examination. Chia seeds demonstrated significantly higher levels of protein, fat, fibre and ash as compared to wheat flour. However, it showed lower values for moisture content and NFE. Moreover, Chia flour contains more phenolic content compared to wheat flour, contributing to its antioxidant potential. The results of current research study are in line with the findings of Adamczyk *et al.* (2021) who stated quite similar results for proximate composition of chia seeds.

### 3.2. Composition analysis of bread

In Table 3 chemical composition of bread made from different composite flours containing various percentages of defatted chia seeds powder is given. The moisture content across all bread samples remained relatively consistent. However, the addition of defatted chia flour significantly increased protein, crude fibre, and ash. In $T_3$ bread, the amount of crude fiber was doubled as compared to the control sample. The World Health Organization (WHO) recommends 30-40 grams of dietary fiber per day. The bread's nutritional value was enhanced by incorporating defatted Chia flour. The inclusion of chia seeds also contributed to better digestive health by promoting intestinal movement, lowering cholesterol, reducing triglycerides, and helping regulate blood sugar levels. Furthermore, chia's fiber content helps promote satiety, which can assist in weight management.

Chia seeds have the ability to fight against cancer and slow down the aging process. The TPC levels were significantly higher in $T_2$ and $T_3$ breads as compared toother breads. In addition, when more Chia flour without fat is added to bread, it becomes better at getting rid of harmful particles in our bodies. Coelho *et al.* (2014), found that adding chia protein hydrolysates to white bread did not change its antioxidant activity. Miranda-Ramos and Millán-Linares (2020) found that the incorporation of chia flour significantly increased the levels of proteins, lipids, and minerals in the bread, thereby enriching its nutritional value. However, Madruga *et al.* (2020) found different results. By the following results it is observed that when defatted chia flour was added to wheat bread, the overall number of antioxidants in the bread increased.

Means having different letters in a row or column indicate significant difference in results

### 3.3. Physical Characteristics
### 3.3.1. Bread Color

The results for color of the bread crumbs are displayed in Table 4. The part of the color that determines how light or dark the bread crumbs are changed from 76.70

**Table 4** Color of bread containing defatted chia flour

| Parameters | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|
| L* | 76.70±0.76$_a$ | 70.75±0.47$_b$ | 70.54±1.56$_b$ | 69.18±0.38$_c$ |
| a* | −0.69±0.05$_d$ | −0.53±0.14$_c$ | −0.36±0.28$_a$ | −0.42±0.43$_b$ |
| b* | 13.68±0.49$_a$ | 12.62±0.48$_b$ | 11.63±0.19$_c$ | 11.61±0.36$_c$ |
| ΔE | 7.79±0.37$_a$ | 6.10±0.24$_b$ | 6.40±0.39$_b$ | 6.70±0.45$_b$ |

**Table 5** Texture profile of bread containing defatted chia flour

| Parameters | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|
| Hardness (N) | 12.95±0.66$_a$ | 12.70±0.43$_a$ | 11.10±0.61$_b$ | 11.90±0.50$_b$ |
| Springiness (ratio) | 0.93±0.01 | 0.94±0.01 | 0.95±0.01 | 0.94±0.01 |
| Cohesiveness (ratio) | 0.70± 0.06 | 0.65± 0.04 | 0.70± 0.06 | 0.70± 0.02 |
| Gumminess (N) | 9.02±0.75$_a$ | 8.73±0.37$_b$ | 7.83±0.10$_c$ | 7.75±0.15$_c$ |
| Chewiness (N × mm) | 9.02±0.26$_a$ | 7.85±0.70$_b$ | 7.40±0.11$_b$ | 7.50±0.12$_b$ |

to 69.18. The other color parameters, $a*$ and $b*$, were between -0.69 & -0.42, and 13.68 & 11.61, respectively. The breads made with defatted chia seeds showed noticeably reduced lightness and yellowness. This suggests that the inclusion of defatted chia flour resulted in a darker and less yellow appearance than the regular bread. The color variation (ΔE) was assessed based on its value following the criteria set by the International Commission on Illumination. The color variation between the regular bread crumb and the one containing defatted chia seeds exceeded 3.5, irrespective of the quantity of defatted chia flour used. This indicates a noticeably different color compared to the standard breadcrumb. When baking bread, the temperature inside the bread is below 100 degrees Celsius, but the outside crust is above 100 degrees Celsius. Defatted Chia flour can be light cream or dark grey in color. The presence of different compounds in defatted chia flour can have an impact on the color.

Means having different letters in a row or column indicate significant difference in results

### 3.3.2. Bread Texture

Results for texture profile of bread made by replacing wheat flour with various percentages of defatted chia flour are presented in Table 5. The bread crumb exhibited a gumminess rating of 9.02N, even in the absence of any supplementary ingredients. The breads made with defatted Chia flour had a less sticky and
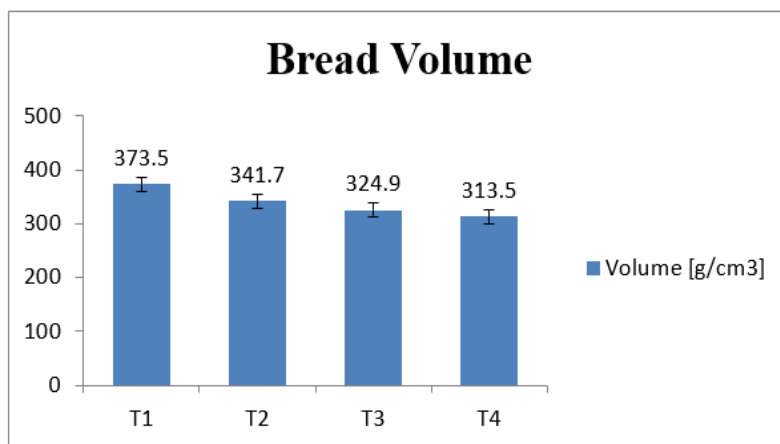


**Figure 1** Volume of bread containing defatted chia flour

chewy texture compared to the control bread. Consumers don't like it when the bread crumbs are extra gummy.

According to the study by Sandri *et al.* (2017), incorporating defatted chia flour into bread made it softer and easier to break apart (with values ranging from 7.32 N×mm to 7.82 N×mm), in contrast to traditional bread, which was firmer and more difficult to chew (9.04 N×mm). Likewise, research conducted by Viswanathan (2014) indicated that adding defatted chia flour to bread makes it less fluffy and weakens the structure of the bread crumb. Furthermore, the researchers observed that incorporating defatted Chia flour had minimal influence on the bread's structural integrity or its ability to rebound.

Means having different letters in a row or column indicate significant difference in results

### 3.3.3. Bread Volume

Results for volume of bread made by replacing wheat flour with various percentages of defatted chia flour are presented in Figure 1. A gradual decrease in bread volume was observed with increasing chia flour substitution. It is obvious from the results that the addition of defatted chia seeds flour gradually decreased bread volume. This might be attributed to the presence of protein and fibre in the defatted chia seed flour. Previously, Sandri *et al.* (2017) discovered that chia seeds could replace gum in gluten-free bread, with higher chia flour levels (5% and 7.5%) reducing bread volume, but no significant change at 2.5%. Moreover, Parker *et al.* (2018) found similar outcomes when they partially substituted wheat flour with chia seeds in bread formulations. They found that the bread was slightly smaller (from 898 to 883 $cm^3$), but the difference was not big enough to be considered important.

### 3.3.4. Sensory Evaluation

The sensory evaluation of breads showed that they looked like well-baked bread, as depicted in Figure 2. In every situation, the bread was delicious and smelled really good. The bread became darker when defatted Chia flour was added, but it was acceptable. For $T_1$ samples, the color of the crumb was much
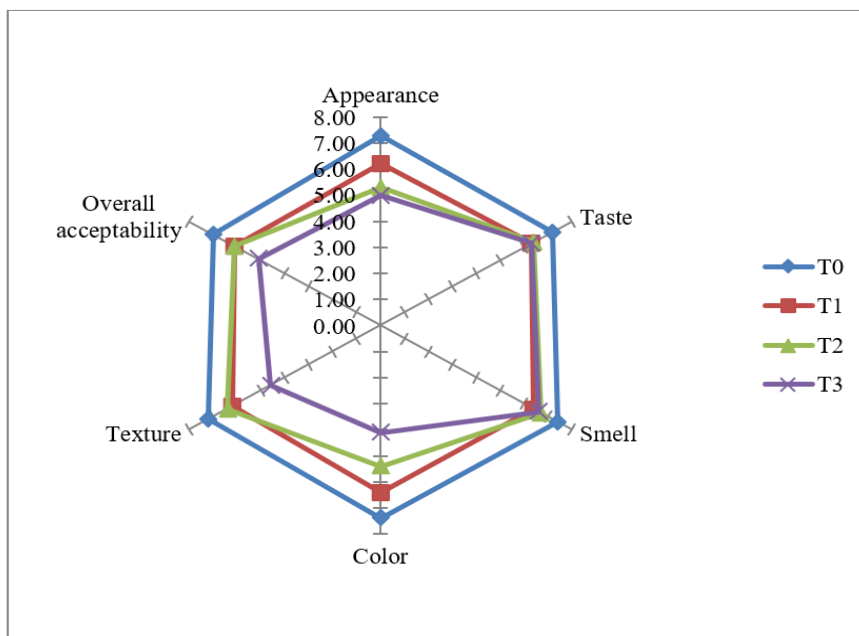


**Figure 2** Sensory Evaluation of bread containing defatted chia seed flour

lighter as compared to the control bread. The markings on the bread show that control bread, $T_1$ and $T_2$ breads were dry and didn't fall apart when cut. They were also very springy. From results it is noticed that the lowest value for texture was exhibited by $T_3$ sample. In conclusion, the bread was given points based on how it was liked by the panelists regarding sensory attributes. Current results matched those found by Sandri *et al.* (2017) who stated similar results for the sensory properties of gluten-free bread with 15% chia flour compared to normal bread. However, the sensory assessment conducted by Kowalski *et al.* (2020) indicated that bread with up to 6% chia seed substitution did not negatively impact consumer acceptance.

## 4. Conclusion

The traditional dominance of wheat flour, a staple in countless kitchens worldwide, is being challenged by a growing fascination with alternative flours driven by health-conscious choices and a quest for nutritional diversity. Wheat flour, with its versatile applications in baking, pasta-making, and beyond, has long been the primary choice for many. However, using defatted Chia flour in the wheat bread recipe made the bread more nutritious. Defatted Chia flour has less fat than wheat flour, twice as much protein, around 8 times more ash, and 13 times more fiber content. This significantly increased the levels of those nutrients in the enriched bread. The higher fiber and phenolic content in chia-fortified bread contributes to potential health benefits, including improved digestive health, better cholesterol management, and enhanced antioxidant activity. Conclusively, incorporating defatted chia flour into bread can be an effective way to add these extra nutrients, making the bread more nutritious and healthy option for the people. This approach not only addresses nutritional deficiencies but also aligns with global efforts to promote healthier dietary choices.

## 5. Statements and Declarations

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# Physico-Chemical Properties and Shelf-Life Study of Aloe-Melon Juice

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## Abstract

Keeping in the view the nutritional value of the Aloe vera and watermelon a formulation of a tasteful Aloe-Melon juice was prepared. The effects of storage and prior processing on lycopene content of juice as well as three weeks shelf-life study of developed Aloe-Melon juice was done. For further satisfaction proximate analysis (moisture, ash, fat, protein, fibre, total sugar, total solids, pH, and acidity) of Aloe *vera* gel and raw Aloe-Melon juice were also conducted. Spectrophotometric method was employed to measure the lycopene value of the product. It was found that the lycopene value of the raw Aloe-Melon juice was minimum but after processing lycopene value was increased. It happened because by nature in raw Aloe-Melon juice, lycopene is present in trans form but during the processing of the juice, trans form was converted into cis form. Additional research validated the shelf-life analysis of Aloe-Melon juice, demonstrating that lycopene levels were consistent, indicating lycopene's stability. Moisture, ash, and fibre values of Aloe-Melon juice were slightly decreased during storage while protein values remained constant. The sample's increasing acidity and decreasing pH caused the values of total sugar to slightly rise. Additionally, the juice's shelf-life testing showed that it kept fresh for three weeks at room temperature. Alkaloids in aloe vera gel were also detected and extracted. The product showed better acceptability, texture, and flavour during storage period. The slight decline in the nutritional values of Aloe-Melon juice amended its taste on small scale but juice did not expire till three weeks.

**Keywords:** Aloe vera gel, Aloe-melon juice, Lycopene value, Nutritional value

## 1. Introduction

The medicinal plant Aloe vera (Aloe *barbadensis* miller) has a rich history of use in medicine and cosmetics dating back centuries. Aloe vera was used by the Chinese and Egyptians in ancient times to heal burns, wounds, and fever (Massoud et al., 2023). Its reputation as a valuable remedy for various diseases, functional disorders, and nutritional conditions, both internally and externally, has persisted for thousands of years worldwide (Vithalkar et al., 2022). Aloe vera is known to enhance metabolism, the process responsible for energy production in the body. This improvement in overall function results in increased energy levels. Remarkably, Aloe vera boasts a composition of 200 nutritional substances, making it one of the most nutrient-rich plants on Earth. Its nutritional profile includes essential vitamins such as B1, B2, B3, B5, and B6; A, C, E, as well as the rare B12. Additionally, it is a rich

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source of minerals, including calcium, magnesium, zinc, manganese, chromium, and selenium, all of which can positively influence brain performance (Shayganfard et al., 2022)

Twenty of the twenty-two amino acids needed for the synthesis of cells and tissues are found in aloe vera. Because anthraquinones are present, it functions as a natural antibacterial, pain reliever, and its gel has a little laxative action (Malik et al., 2016). Watermelon, on the other hand, is a versatile fruit enjoyed in numerous ways, often used to flavor summer drinks and smoothies. With 92% water content and about 6% sugar by weight, watermelon is not only hydrating but also a delicious treat. It is rich in beta-carotene, and deep red varieties supply a substantial amount of lycopene, a powerful antioxidant that supports heart, prostate, and skin health. Cherries and strawberries lack the carotenoid pigment lycopene, which is present in tomatoes, watermelons, as well as other red fruits and veggies including papayas and red carrots. Beyond its antioxidant properties, lycopene may have additional benefits, including effects on gap-junction communication, hypocholesterolemic, anti-cancerous, and anti-atherogenic effects, potentially lowering the likelihood of certain chronic illnesses (Khan et al., 2021). The current study aims to create a delectable Aloe-Melon juice recipe, evaluate its nutritional value, and look into how processing and storage affect the juice's lycopene content.

## 2. Materials and Methods

Following reagents were used in the research 1.25 % $H_2SO_4$, 1.25% NaOH, N/70 HCl, 40 % NaOH, 6 N HCl, 0.1 N NaOH, Acetic acid ( 5 % aq. soln. ), $Na_2CO_3$( 10 % aq. soln. ), Benedict's solution, Mayer's reagent, Dragondroff's reagent.

Preparation of Aloe Melon juice was done by the extraction of Aloe gel followed by extraction of Melon juice then formulation of Aloe-Melon juice.

(Khan et al., 2012). A sample was prepared as; 4 to 5 leaves of mature aloe vera plant were taken and cut the skin off and rinsed the yellow sap off with water. Clear gel was obtained. Using an electric blender, the equal weight of watermelon purée and aloe vera gel were mixed for two minutes. Then, 0.05% sodium benzoate along with few drops of strawberry essence was thoroughly mixed in small amount of Aloe-Melon juice and after mixing, this juice was poured in bulk amount of juice during constant stirring. ˚Brix was adjusted to 12 by adding sugar in it and juice was poured in sterile bottles.

### 2.1. Physico-Chemical analysis

Various physico-chemical characteristics such as moisture, residual ash, fat, protein, crude fiber, total solids, titerable acidity, brix: acid ratio, pH and total sugar were determined by the methods described by (Appaiah et al., 2015). Lycopene content from juice was extracted by the method reported by (Martínez-Hernández et al., 2016) Alkaloids were detected and extracted by the method (Gul et al., 2017)

### 2.2. Extraction of Lycopene

A combination of acetone and petroleum ether was used to extract the lycopene. Initially, 10 grams of the sample were weighed and placed in a pestle mortar. A small volume of acetone (20-25 mL) was combined with the sample, and the mixture was ground until the residue became colorless. Whatman filter paper that had been soaked with acetone before the filtration process was used to filter the resultant mixture through a Buchner funnel. The filtrate obtained was collected and used for the later separation step. In the ultimate step of sample preparation, the filtrate was poured into a 125 mL separating funnel holding 15 mL of petroleum ether and 50 mL of distilled water. Two separate layers were allowed to develop in the solution by letting it sit for over five minutes after gently mixing it. The bottom layer,

making up unwanted components, was carefully separated and discarded, leaving the upper layer holding lycopene. This upper layer was collected into a labeled clean beaker and covered with aluminum foil. The volume of the sample was measured, and a small amount of $Na_2SO_4$ (0.5 gm) was added to the solution. A spectrophotometer was used to quantify the amount of lycopene inside a 1 cm cell at 503 nm. Petroleum ether was used as the blank (standard). The link between the absorbance of a 1 cm cell and 3.1206 μg of lycopene per mL was used to compute the sample's lycopene value (Poojary and Passamonti, 2015).

## 2.3. Detection and Extraction of Alkaloids

The process of extracting Aloe vera leaves involved several steps:

Preparation of Aloe Vera Powder: Dried Aloe vera using a mortar, leaves were pulverized into a fine powder.

2.3.1. Methanol Extraction: 400 ml of methanol were used to extract 100 grams of powdered aloe vera leaves. The extraction process took place for approximately 2 days with continuous swirling.

To get rid of solid particles, the extract was then filtered via Whatman No. 1 filter paper after two days.

2.3.2. Solvent Removal: The solvent was removed from 200 mL of the filtrate by allowing it to stand at room temperature for one day.

2.3.3. Acidic Extraction: Following solvent removal, 100 ml of 5% aqueous acetic acid were used to extract the residue. The extract was filtered an hour later.

2.3.4. Dichloromethane Extraction: The filtrate from the acidic extraction was further extracted with 50 mL of dichloromethane using a separating funnel.

2.3.5. Basification and Second Dichloromethane Extraction:The organic layer was basified to pH 10 using a 10% aqueous solution of sodium carbonate in order to separate the aqueous layer from the organic layer.

The mixture was then extracted once again using a separating funnel and 50 mL of dichloromethane.

2.3.6. Evaporation: To remove the alkaloid residue, the organic layer from the second extraction was isolated and allowed to evaporate. Alkaloids were extracted and isolated from Aloe vera foliage as a result of this procedure.

Detection of alkaloids in dichloromethane extract was treated with Mayer's reagent.

## 2.4. Thin-Layer Chromatography

The following procedures were used to perform the Thin-Layer Chromatography (TLC) examination of the Aloe vera extract:

- TLC Plate Preparation: Aluminum TLC plates coated with silica gel were used for the analysis.
- Spotting the Mixture: A small amount of the Aloe vera extract mixture was spotted near the end of the TLC plate.
- Developing Chamber Setup: The TLC plate was set inside a developing chamber that held a 10:90 solvent combination of methanol and chloroform. Using capillary action, the solvent moved progressively up the TLC plate in its role as the mobile phase.
- Solvent Movement: As the solvent moved up the plate, it carried the components of the Aloe vera extract with it.
- Plate Drying: The TLC plate was taken out of the developing chamber once the solvent had reached the top of it, which took about an hour.
- Spraying with Dragondorff's Reagent: The dried TLC plate was sprayed with Dragondorff's reagent, a chemical solution used for alkaloid detection.
- Visualization under UV-Light: The separated components of the Aloe vera extract were visualized under UV light in the range of 200-380 nm.

**Table 1** Raw Aloe vera gel, proximate analysis

| Sr. No. | Parameters studied (%) | Raw Aloe vera gel |
|---|---|---|
| 1. | Moisture | $98.52 \pm 0.002$ |
| 2. | Ash | $6.79 \pm 0.141$ |
| 3. | Protein | $2.54 \pm 0.032$ |
| 4. | Fat | $0.149 \pm 0.020$ |
| 5. | Crude Fibre | $17.07 \pm 0.019$ |
| 6. | Total sugar | $20.46 \pm 0.165$ |

**Table 2** Aloe-Melon juice at early point of storage, proximate analysis

| Sr. No. | Parameters studied (%) | Aloe-Melon juice at preliminary step of storage |
|---|---|---|
| 1. | Moisture | $85.65 \pm 0.056$ |
| 2. | Ash | $1.57 \pm 0.014$ |
| 3. | Protein | $1.13 \pm 0.023$ |
| 4. | Crude fibre | $17.57 \pm 0.01$ |
| 5. | Total Sugar | $24.31 \pm 0.231$ |

**Table 3** Aloe-Melon juice at finishing step of storage, proximate analysis

| Sr. No. | Parameter studied ( %) | Aloe-Melon juice at finishing step of storage |
|---|---|---|
| 1. | Moisture | $85.21 \pm 0.048$ |
| 2. | Ash | $1.47 \pm 0.021$ |
| 3. | Protein | $1.12 \pm 0.012$ |
| 4. | Crude fibre | $17.33 \pm 0.014$ |
| 5. | Total sugar | $24.82 \pm 0.235$ |

This process allowed for the separation and detection of alkaloids in the Aloe vera extract, with Dragondorff's reagent aiding

in the visualization of the separated components. (Chowbey et al., 2022) (Poojary et al., 2015)

## 3. Results and Discussion

The goal of this study was to create a palatable Aloe-Melon juice formulation so that the impacts of production and packaging on the juice's lycopene concentration and physico-chemical characteristics could be investigated, along with a three-week shelf life study. Lycopene value was less in the raw Aloe-Melon juice and increased in the processed Aloe-Melon juice as shown in Table 6. The analysis demonstrated that cooking effectively enhanced the lycopene contents in Aloe-Melon juice as reported by (Khan et al., 2012). Following processing, the juice's lycopene concentration rose because of heat-induced isomerization over all to cis-forms. An unstable, energy-rich condition is produced during processing, which leads to this isomerization. As a result, processed lycopene products have a greater bioavailability of lycopene than unprocessed ones.

The proximate evaluation of crude Aloe vera gel is provided in Table 1. The proximate investigation of Aloe-Melon juice at the beginning and end of storage is displayed in Tables 2 and 3, respectively. The moisture parameters were 85.65 at the first stage and 85.21 at the final stage, showing a slight decrease in moisture content during the storage period. There was a little drop in ash content throughout storage, as seen by the

**Table 4** Outcome of storage time on determination of Total Solvable Solids (˚Brix), Aloe-melon juice's tierable acidity and Brix:Acid ratio

| Sr. No. | Parameters Studied | Storage Time | | |
|---------|-------------------|--------------|---|---|
| | | 1st week | 2nd week | 3rd week |
| 1. | Brix (%) | 12 | 13 | 12.75 |
| 2. | Acidity (%) | 0.07 ±0.0019 | 0.057 ± 0.0014 | 0.070 ± 0.0019 |
| 3. | Brix: Acid ratio | 171 | 228 | 182 |

**Table 5** Effect of storage time on quality attributes of Aloe-Melon juice

| Sr. No. | Quality attributes | Storage Time | | |
|---------|-------------------|--------------|---|---|
| | | 1st week | 2nd week | 3rd week |
| 1. | pH | 5.28 | 5.38 | 4.93 |
| 2. | Colour | Melon red | Melon red | Melon red |
| 3. | Consistency | Homogenous with no separation | Homogenous with no separation | Homogenous with no separation |
| 4. | Taste | Highly acceptable | Acceptable | Slightly acceptable |
| 5. | Flavour | Pleasant | Pleasant | Pleasant |

**Table 6** Determination of lycopene content of Aloe-Melon juice and effect of storage period on lycopene stability

| Sr. No. | Parameters studied | Lycopene values/100 gm | | |
|---------|-------------------|------------------------|---|---|
| | | Storage time | | |
| | | 1st week | 2nd week | 3rd week |
| 1. | Fresh watermelon | 2.38 ± 0.118 | 2.3 ± 0.118 | 2.1 ± 0.024 |
| 2. | Raw Aloe-Melon juice | 0.115 ± 0.0001 | 0.115 ± 0.0001 | 0.114 ± 0.0002 |
| 3. | Processed Aloe-Melon juice | 0.404 ± 0.0008 | 0.404 ± 0.0008 | 0.402 ± 0.0003 |

ash content values at the beginning and end of storage, which were 1.57 and 1.47, respectively. Protein amounts in Aloe-Melon juice were nearly consistent during storage, as seen by the protein values of 1.12 and 1.13 for the juice at the beginning and end of storage, respectively.

Crude fiber content decreased in Aloe-Melon juice as measured by crude fiber values, which were 17.57 and 17.33 at the beginning and end of storage, respectively. The decrease in crude fiber was associated with a reduction in ash content. At the beginning of storage, the total sugar content was 24.21; at the end of storage, it had somewhat grown to 24.82. This little rise in sugar might be explained by the transformation of non-reducing sugars into reducing sugars, which also results in a drop in pH and an increase in acidity. The information for acidity, Brix: Acid ratio, and total soluble solids (^Brix) is shown in Table 4. The table indicates a rise in ^Brix (T.S.S) of Aloe-Melon juice throughout the course of storage, which may be related to the enzymatic or hydrolysis-induced inversion of sucrose. This finding aligns with the results reported by (Khan et al., 2012) During storage, the percentage acidity of the Aloe-Melon juice rose, possibly as a result of the oxidation or breakdown of the sample's reducing

sugars, which produced acidic chemicals, as reported by (Rasmussen et al., 2014).

One of the most important metrics for evaluating the quality of juice is the Brix: Acid ratio, which is the proportion of °Brix to the grams of dried citric acid in 100 g of concentrate or citrus juice. For example, if a juice sample has 12 °Brix and 0.07 acidity in the 1st week of the study, the Brix: Acid ratio would be 171, indicating that for every 171 parts of soluble solids (mostly fruit sugar), there is one part of acid. The Brix: Acid ratio increased during storage as both the °Brix and acidity values increased.

Table 5 presents the quality attributes of Aloe-Melon juice. The pH of the juice remained almost constant during the 1st and 2nd weeks of storage but decreased in the 3rd week, likely in response to the increasing acidity in the juice during storage. The production of acidic chemicals because of the oxidation or breakdown of the juice's reducing sugars may be the cause of the pH drop.

There was no considerable change in the colour of Aloe-Melon juice, and its consistency remained homogeneous without separation. The taste quality of the juice was highest in the 1st week of storage

and lowest in the 3rd week. This variation in flavour might be caused by the passage of time and the temperature at which the food is stored, which can break down ascorbic acid and produce furfural, as reported by (Wadhwa et al., 2016). The flavour quality remained high throughout the storage period.

Through a variety of techniques, the existence of alkaloids in Aloe vera leaves was verified. Pale yellow precipitates were produced when some drops of Mayer's reagent were introduced to the Aloe barbadensis extract, suggesting the presence of alkaloids (Jha et al., 2019). Additionally, the detection of alkaloids was performed using Thin-Layer Chromatography (TLC). The TLC analysis of the Aloe vera extract revealed orange spots on the chromatogram, further confirming the presence of alkaloids in the extract (Khan et al., 2015). These orange spots on TLC plates are attributed to the presence of steroids in the Aloe vera gel extract.

# 4. Conclusion

The product showed better acceptability, texture, and flavour during storage period. The slight decline in the nutritional values of Aloe-Melon juice

amended its taste on small scale but juice did not expire till three weeks.

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# Overweight among Undergraduate Students in University of Narowal, Narowal, Pakistan: A Descriptive Cross-sectional Study

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## Abstract

Obesity is common problem in both developing and under-developing countries and may often accompanied with various complications, including diabetes, hypertension and metabolic disorders. This study aims to evaluate the prevalence of obesity and overweight among undergraduate students from University of Narowal. The cross-sectional analysis was obtained from a general population (n=568) of undergraduate students enrolled between 2020-2022. The data obtained through questionnaire included demographic information and anthropometric measurements. More than a half of population (n=374, 66%) showed normal BMI= $21.1\pm0.01$ while 96 (16.9%) students (Mean BMI= $26.7\pm0.1$) were overweight, 20 (3.5%) students (Mean BMI= $32.69\pm0.49$) were obese, and 48 (8.5%) students (Mean BMI= $17.91\pm0.120$) were found to be underweight. This study shows a least significant prevalence of obesity in general population serving as a crucial component in the indication of a good public awareness about obesity and healthier life style.

**Keywords:** BMI, Obesity, Overweight, Undergraduates, Underweight

## 1. Introduction

Obesity is a multifactorial metabolic disorder which generally refers to the accumulation of excessive body fats that might cause impairment of several bodily functions (Kumar et al., 2021; Blüher et al., 2019). Obesity is associated with an increasing rate of various metabolic diseases including, hypertension, cardiovascular disorders, type 2 diabetes, fatty liver disease and musculoskeletal disease (Blüher et al., 2019). World Health Organization (WHO) targets a halt the rise in obesity through "Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020"

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**Table 1** Classification of overweight and obesity by BMI

| Sr. | Categories | BMI kg/cm$^2$ |
|---|---|---|
| 1. | Underweight | <18.5 |
| 2. | Normal | 18.5-24.9 |
| 3. | Overweight | 25.0-29.9 |
| 4. | Obesity | 30.0-39.9 |
| 5. | Morbid Obesity | $\geq 40$ |

and its reduction to a level it was in 2010 (World Health Organization, 2013).

The prevalence of obesity varies in different geographical regions due to the change in life styles and environmental factors under the influence of economic development, expansion of cities and innovation. The prevalence of obesity was 16.4% in adults (≥18 years) in China ((Pan et al., 2021), 5% in India (Motwani et al., 2021), 21.4% in Iran (Vaisi-Raygani et al., 2019) and 11.7% in Malaysia (Rampal et al., 2007). An extensive meta-analysis showed highest prevalence of 35.0% in Saudi Arabia, and lowest prevalence of 2% in Vietnam during COVID pandemic (Jayawardena et al., 2020). A study predicts the prevalence of obesity of 48.9% in USA by the year 2030 [9]. There are several socioeconomic factors which include work absenteeism, quality of life, transportation costs, obesity-related diseases, premature death and lower work productivity. These all factors are major contributors of obesity prevalence in a community (Anekwe et al., 2020).

Obesity holds a variety of other psychological and other health complications with itself, as there are higher rates of cardiovascular diseases (CVD), diabetes and hypertension in obese persons. Obesity may also lead individuals to have different infectious diseases (Haslam et al., 2005; Falagas et al., 2006). Higher mortality rates in obese populations in America and Africa has also been observed (Stevens et al., 2000). The incidence of cancer is significantly associated with obesity as 33% excess incidence of various cancers has been observed in obese persons (Wolk et al., 2001).

Although Body mass index (BMI) is an indirect way of estimating the obesity but still it is a good predictor of obesity as WHO states that the BMI ≥30kg/m$^2$ is obese. The term BMI was first used by Ancel Benjamin Keys (Cole et al., 1979) which he defined as the ratio of weight (kg) to square of height (m$^2$). The normal value of BMI ranges between 18.5-24.9, the lower values show underweight, and higher values indicate overweight and obesity (Gupta et al., 2009) (**Table 1**).

The change in life style, use of technology and modernization reduced the physical activity in young generation thereby making them more vulnerable to obesity and its associated comorbidities. Approximately 52% of adults of 18 years and above are overweight or obese according to a WHO report in the year 2016. The rate of obesity and overweight in undergraduates is also increasing sharply (Ha & Kim, 2017) Overweight and obesity not only affects the health, stature and way of life but also cause serious health problems and impediments in pshyco-social health (Morrison et al., 1999; Owen et al., 2009; Raghuveer et al., 2010) ultimately affecting the development of country.

This cross-sectional study aims to evaluate the prevalence of obesity among the undergraduates from rural and urban backgrounds. Moreover, it also highlights the gender-based prevalence of obesity.

## 2. Materials and Methods
### 2.1. Study Design
A survey-based questionnaire among the undergraduates enrolled between 2020-2022 was conducted in University of Narowal.

### 2.2. Sample Size and Selection Criteria

This study utilized a general population (n=568) with individuals from rural areas in close proximity of Narowal and nearby urban communities. Undergraduate students between the age 17 to 25 years regardless of the residence and gender were selected for sampling.

### 2.3. Materials/Instruments

A well-structured questionnaire in Google Forms was presented to each student to fill the demographics such as names, age, sex, residency, and anthropometric measurements such as weight (kg) and height (m) was collected for further calculation of BMI. The collected data was structured and formatted in Microsoft Excel 2019. Mean, percentages and BMI category-wise prevalence were calculated in IBM SPSS version 21.

### 2.4. Data Analysis

Prevalence of different BMI categories on the basis of sex was calculated using percentage and mean values through Compare Means function in SPSS. Sex and BMI categories was considered as independent variables against age and BMI values being dependent variables. Clustered boxplot was created for BMI categories against the mean BMI values while a bar chart was produced to analyze the percentage prevalence of BMI categories in males and females.

## 3. Results and Discussions

### 3.1. Mean Analysis of General Population

Mean analysis of the whole population shows the population (n=568) with females (n=363) and males (n=205) of mean age 20.7 years and 21.0 years with mean BMI values 22.0 kg/m2 and 22.6 kg/m$^2$ for females and males respectively as shown in **table 2**.

### 3.2. Percentage Prevalence Analysis

Individuals in each BMI category were analyzed using percentage (**Table 3**). 70 out of 568 students, 22 male and 48 female with their mean BMI values 18.0±0.1 and 17.9±0.1 respectively, were found to be underweight. Most of the population was having normal weight as the data indicates that 375 male and female students have their BMI in normal range (mean BMI 21.1±0.01). The prevalence of overweight was 16.9% in general population (males with 7% and females with 10% approximately). The incidence of obesity was shown to be very least in males (i.e., 1.1%) as compared to females (3.5%). Only one male student was found to be morbid obese with BMI≥40 kg/m$^2$.

**Table 2** Characteristics of population under study and mean values

|  | Population size (%) | Mean Age (kg) | Mean BMI (kg/m$^2$) |
|---|---|---|---|
| Females | 363 (63.9%) | 20.7 ± 0.07 | 22.0 ± 0.19 |
| Males | 205 (36.1%) | 21.0 ± 0.12 | 22.6 ± 0.27 |
| Total | 568 (100.0%) | 20.9 ± 0.06 | 22.2 ± 0.16 |

**Table 3** BMI

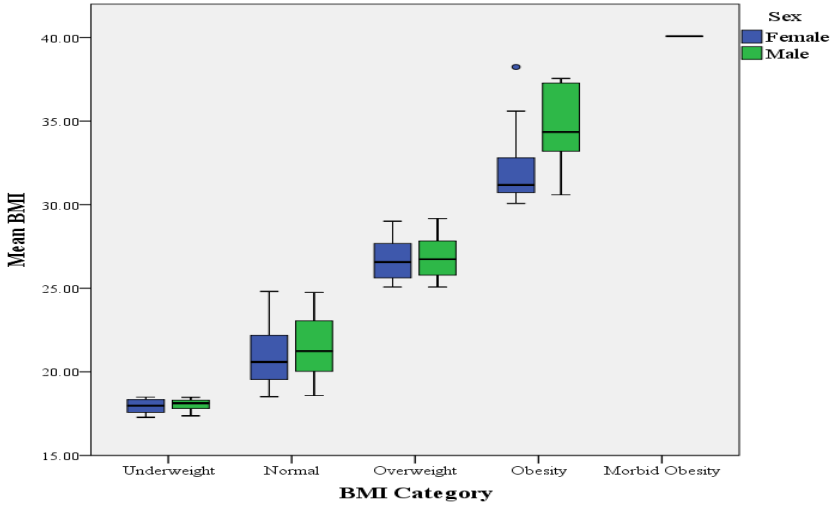| BMI Category | Male | | | Female | | |
|---|---|---|---|---|---|---|
|  | N (%) | Mean Age (years) | Mean BMI (kg/m$^2$) | N (%) | Mean Age (years) | Mean BMI (kg/m$^2$) |
| Under weight | 22 (3.9) | 20.7±0.3 | 18.0±0.1 | 48 (8.5) | 21.0±0.2 | 17.9±0.1 |
| Normal | 136 (23.9) | 21.07±0.1 | 21.5±0.2 | 239 (42.1) | 20.5±0.1 | 20.9±0.1 |
| Overweight | 40 (7.0) | 21.3±0.2 | 26.8±0.2 | 56 (9.9) | 21.3±0.2 | 26.7±0.2 |
| Obesity | 6 (1.1) | 20.0±0.5 | 34.5±1.0 | 20 (3.5) | 21.1±0.3 | 32.1±0.4 |
| Morbid Obesity | 1 (0.2) | 22±0.0 | 40±0.0 | N/A | N/A | N/A |

**Figure 1** A cluster boxplot showing plots of different mean BMI categories with respect to sex

Overall, the results of this study have shown no significant prevalence of obesity among undergraduate students in University of Narowal. But the statistics indicate a slightly increased prevalence of underweight in male as well as female students

According to a report, an increase in physical activities and exercise with dietary restriction leads to greater weight loss as compared to change in diet (Stiegler et al., 2006). Also, there are reports which show that certain factors responsible for the overweight and obesity are more concerned with the lifestyle of the person. The most important factors that lead to obesity are the use of technologies such as computers in case of students for prolonged durations, more intake of food under stressed conditions and the intake of high fatty foods (Bakr et al.,2002). Overweight and obesity are emerging as one of the major problems in younger populations. An increase in the prevalence of overweight is observed in both developed and developing countries, notably United States, Brazil and China are most common according to a recent study (Kapil et al., 2002).

Our findings align with (Chhabra et al., 24), where 11.75% were overweight and 2% were obese among medical students.

According to a survey in China, about 6.2% prevalence of overweight was studied in Chinese youth which is less than that value reported in Pakistan. The reason of lower prevalence in Narowal could be that the life style includes more physical activities, which results in low fat deposition. In 1963-1991 the National Health and Nutrition Examination Surveys in USA reported that prevalence of overweight increased in all age groups and sexes in a chronological manner (Troiano et al., 1995).

In consistency with the previous studies on overweight in China, recently the morbidity of overweight-obesity is greater in case of males than in females (Yi et al., 2012; Guo et al., 2013; Song et al., 2013). As compared to boys, girls are more likely to control their body weight and their height. According to a research, boys spend more money on junk food, beverages and spend most of their time on mobile phones, computers and games as compared to girls (Zhang et al., 2016). There is no information available on underweight in Indian urban youth, however the same prevalence was reported for Chinese and Russian youth. Our study has shown a slight greater prevalence of obesity in females as compared to males (**Figure 2**).
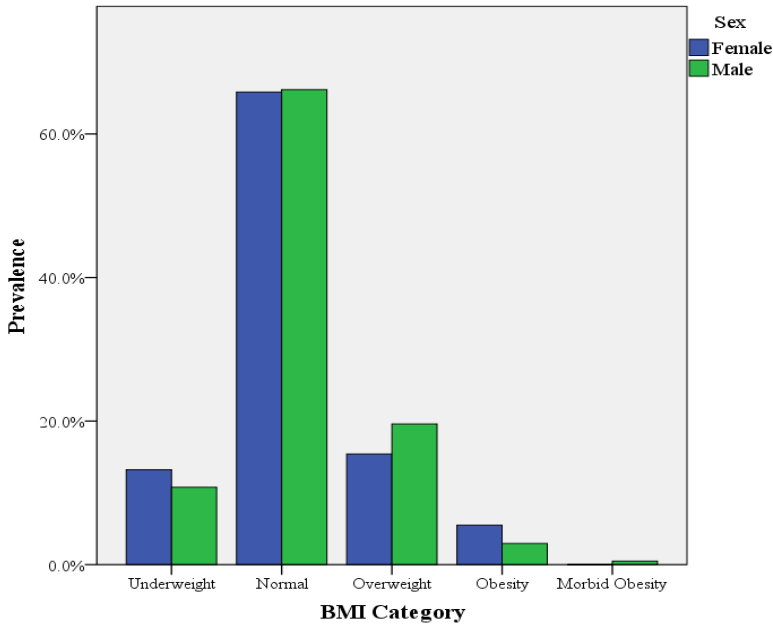
**Figure 2** Bar chart showing percentage prevalence between males and females in different BMI categories.

### 3.3. Limitations

Our study has certain limitations that need to be acknowledged. Firstly, the use of BMI as a sole parameter to investigate the prevalence of obesity may not provide a comprehensive assessment, as factors such as waist circumference and variability across different age groups can influence BMI values. Secondly, the study's reliance on a questionnaire-based methodology introduces potential biases, including inaccuracies in self-reported weight and height. Moreover, the regional scope of the study may limit the generalizability of the findings. A larger cohort study, incorporating a more detailed questionnaire that includes additional anthropometric measurements, dietary habits, physical activity routines, smoking status, and family history, would help to address these limitations and provide more robust results.

### 4. Conclusion

Obesity, as a multifactorial disorder, increases complications and negatively influences daily life. Modernization and reduced physical activity, particularly among the younger generation, contribute to the rising prevalence of obesity. However, there are regions in Pakistan where obesity is less prevalent. Our study at the University of Narowal found a notably low prevalence of obesity among undergraduate students, suggesting better health outcomes within this specific population, as evidenced by their higher levels of physical activity and healthier lifestyle habits.

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**Conflict of interest disclosure:**

Authors have declared that there is no conflict of interest.

**Data Availability**

Data is available on request.

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# A Review on Pathophysiological Factor of Hypertension in Pakistan, its Regulation and Management

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## Abstract

Hypertension is a major health issue that affects people all over the world. It has a significant effect on the patient's quality of natural life and existence due to the associated morbidity and mortality issues. Blood pressure control that is optimized has been found to expand global health results. There is a scarcity of current data on the dominance of hypertension in Pakistan's residents. The cross-sectional study is based on records collected between 2008 and 2015 during numerous health screening camps organized in the countryside of central Punjab, Pakistan. The overall prevalence of high blood pressure was 35.1 percent, with a 34.4 percentage-standardized prevalence. 62.3 percent of patients with HTN were aware that they had high blood pressure, and 75.3 percent were already receiving medication for it. In recent decades, various dietary modules such as salt, Potassium (K), calcium (Ca), and magnesium (Mg) have been extensively investigated. While some of these nutrients have strong evidence to support their use, others are contentious and are still being researched. Dietary changes are frequently conferred through patients and can have a significant impact on blood pressure control. Blood pressure was managed in 32.3 percent of individuals taking hypertension medication. Nearly a third of patients at rural central Punjab health screening camps have hypertension. These patients had a low rate of blood pressure control.

**Keywords:** Hypertension, Morbidity, Dietary component, Medication, Health

## 1 Introduction

In the created world, hypertension is a significant medical problem. Hypertension is frequently asymptomatic for a long time, although it can sometimes arise in an intense forceful structure. Raised blood vessel pulse is an essential gamble of untimely vascular ailment, prompting cerebrovascular occasions, ischemic coronary illness, and fringe vascular infection, as indicated by an epidemiological review. Pulse, similar to tallness and weight, is a singular character with critical interindividual variety and a ceaseless distribution (Smith et al., 2013).

Hypertension, which is ordinarily characterized as a steady pulse (BP) of 140/90 mm Hg in the clinical office, is one of the main sources of untimely dreariness and mortality in the United States. Hypertension, then again, is expected to increment in pervasiveness by 60% by 2025, influencing 1.56 billion individuals universally. Financially developing nations will have an ascent of 80%(from 639 million to 1.15 billion). Hypertension is a significant local area medical problem, with a worldwide breadth of 40.8 percent and a 32.3 percent control rate (Gitinkwi et al., 2020).

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| Condition | Systolic blood pressure (mm Hg) | | Diastolic blood pressure (mm Hg) |
|---|---|---|---|
| Normal | ≤120 | and | <80 |
| Pre-hypertension | 120–139 | or | 80–89 |
| Stage 1 hypertension | 140–159 | or | 90–99 |
| Stage 2 hypertension | ≥160 | or | ≥100 |

**Figure 1.** Hypertension and its related Diagnoses

Hypertension is a significant gamble for an assortment of huge sicknesses, including coronary illness, stroke, and persistent kidney infection. Hypertension-related outcomes are liable for 9.4 million fatalities around the world, as well as 45% of the death from coronary supply route illness and 51 percent of the theater stroke (González-Gómez et al., 2018). Hypertension is wider in low-pay nations, where cardiovascular infection represents generally 80% of all death. In Pakistan, two enormous epidemiological examinations observed hypertension predominance paces of 19.1 percent and 14 percent, separately, in light of the 1990-1994 National Health Survey and provincial northern segments of the country. These examinations, in any case, are not characteristic of the momentum illness trouble because the information was gathered 15-20 years prior. Populace development, age and changes in social risks have all been connected to worldwide expansions in the commonness of hypertension after some time, as indicated by studies from different countries. Punjab is Pakistan's most crowded territory. In the course of the most recent eight years, a nephrology department of a tertiary care medical clinic in rural Punjab has held an enormous number of wellbeing screening camps to further develop wellbeing and bring issues to light about hypertension, diabetes, and ongoing kidney illness among the overall population. In light of information acquired during these wellbeing screening camps, this study expects to give updated information on the predominance, mindfulness,

management, and control of hypertension(Feist et al., 2021).

All medical care professionals go over individuals who could profit from lower circulatory strain consistently. Patients with confirmed hypertension and pre-hypertension (systolic 120-139 mm Hg) had a higher gamble of cardiovascular occasions than those with ideal (120/80 mm Hg) or typical (120-129/80-85 mm Hg) BPs show in figure 1. More individuals may almost certainly become a possibility for antihypertensive treatment before long as clinical preliminaries show the advantages of treatment (even pre-hypertension) and pharmacological methodologies become more secure and more viable (Lule et al., 2019). Besides pharmacological treatment, most of the people more than 40 years of age would profit from the way of life changes. A hypothetically protected general well-being way to deal with bringing down circulatory strain that moves the expenses of treatment (whether diet, work out, or both) from the medical services framework to the singular. A considerable lot of the restorative way of life changes that lower pulse or slow the pace of circulatory strain rise ought to be embraced into everybody's way of life at the earliest opportunity (Deepak et al., 2021).This study analyzes the latest epidemiological information on hypertension predominance, mindfulness, treatment, and control with verifiable information from Pakistan to differentiate the customary and perhaps future meanings of hypertension. The risks of having hypertension are recorded. A few places of BP estimation that are right now

accessible and recommended are talked about under (Shaheen et al., 2021).

## 1.1 Epidemiology and Risk

Presently, medical practitioners and individuals seeking healthcare seldom prioritize the reduction of elevated blood pressure solely for the purpose of mitigating specific symptoms or maladies correlated with this condition. Instead, because of the increased risk of long-term morbidity and mortality associated with hypertension, as well as the knowledge that antihypertensive medication avoids some (but not all) of these occurrences, hypertension is routinely and adequately treated (Hartle et al., 2016). Several epidemiological investigations established in 1948 through the Framingham Heart Study and continuing to the present day have demonstrated the hazards associated with high blood pressure. In both Western and Eastern populations, meta-analyses of collective data have established the robust, constant association between blood pressure and cerebrovascular syndrome and coronary heart syndrome (Andersson et al., 2019). Left ventricular hypertrophy, heart failure, peripheral vascular disease, carotid atherosclerosis, end-stage renal disease, and "subclinical CV disease" are all linked to high blood pressure. Hypertensive patients are substantially more expected than normotensive individuals to suffer from type II diabetes or dyslipidemia particularly raised triglycerides and low high-density lipoprotein cholesterol (HDL-C) (Wollert et al., 2017).

## 1.2 Hypertension with Age

The elderly is the world's fastest-growing population segment. The hypertension prevalence rate increases with age, according to data collected over 30 years. This hypertensive subgroup also has a higher risk of coronary artery disease, stroke, dementia, prolonged renal disease, and congestive cardiac failure. Cardiovascular specialists and other practitioners have a therapeutic conundrum when it comes to hypertension in the elderly (Corrada et al., 2017). Before the findings of the Systolic Hypertension in Europe Trial were released, the prevailing medical belief was that blood pressure values should not be reduced in the same way that they were in younger patients to avoid ischemic events and poor organ oxygenation (brain, heart, kidney) (Corrada et al., 2017).

## 1.3 Gender and Hypertension

It is commonly known that as people get older, the prevalence of hypertension varies between men and women. A cross-sectional survey was carried out in several parts of Pakistan. The researchers gathered information on sociodemographic and clinical factors. A total of 9442 people aged 15 and up were counted. Mother's tongue identified different regional sub-groups including, Punjabi, Muhajir, Pashtun, Sindhi and Baloch (Jafar et al., 2004). Baluchi (25.3 and 41.4 percent in men and women) had the highest age-standardized prevalence of hypertension, followed by Pashtuns (23.7 & 28.4 percent in men & women), Muhajirs (24.1 & 24.6 percent in men and women), Punjabis (17.3 & 16.4 percent in men and women), and Sindhis (17.3 & 16.4 percent in men and women) (19.0 & 9.9 percent in men and women). In cities, hypertension was more than in rural areas. After controlling for socio-demographic, nutritive and clinical risks however, ethnic differences remained (Afzal et al., 2013).

## 1.4 Race/Ethnicity and Hypertension

This broad geographic designation obscures the region's incredible national and cultural variety to the point that it's largely irrelevant. East Asia is made up of three countries: Japan, Korea, and China, all of which are culturally distinct in many ways. Even among Taiwanese aborigines (who are akin to South Pacific Islanders), Hakka (Han subgroup), and Minnan, there are significant distinctions (Taiwanese). One commonality appears to be a high intake of dietary salt, which is

linked to an increased risk of heart failure. Calcium antagonists and diuretics appear to be the most effective treatments for hypertension in such people. East Asians tend to have a higher incidence of cough related to ACE inhibitor use (Deere et al., 2020).

The term "South Asian" ignores the vast differences that exist inside India and between India and other countries in the region. Pakistan is a good example of this, as it is made up of four states with very varied cultures. Women from Baluchistan, Pashtuns, Muhajirs, Punjabis, and Sindhis have the highest frequency of hypertension. The researchers were unable to pinpoint a cultural explanation for the disparities (Saleem et al., 2010).

# 2 Regulation of Blood Pressure

## 2.1 Neurogenical

The vasomotor center includes the nucleus tractus solitarius in the dorsal medulla, a posterior region of the ventral medulla, and other centers in the Pons and midbrain. Arterial baro-receptors afferent impulse activity increases in response to distension of the artery wall. This raises vagal tone and decreases efferent sympathetic activity. The outcome is bradycardia and vasodilation (Moore et al., 2011).

## 2.2 Renin-angiotensin system

All angiotensin peptides come from angiotensinogen, the renin substrate. While some exploration infers angiotensinogen substrate is abundant in human plasma when contrasted with renin, others recommend that adjustments of plasma angiotensinogen levels can fluctuate the Renin-angiotensin system relative movement. For instance, a human Alanine:glyoxylate Aminotransferase quality variety connected to more noteworthy plasma levels of angiotensinogen has additionally been connected to the improvement of hypertension. Moreover, quality titration tests in transgenic mice with 0 to 4 duplicates of the AGT quality uncovered a positive connection between the quantity of AGT quality duplicates, plasma levels of angiotensinogen, and circulatory strain. Besides, a new report uncovers that oxidative pressure-actuated modifications in the design of the angiotensinogen particle can radically change the energy of renin breakage. These discoveries recommend that oxidative pressure might apply free control on the action of the RAS by advancing the development of angiotensin I(Lu et al., 2016).
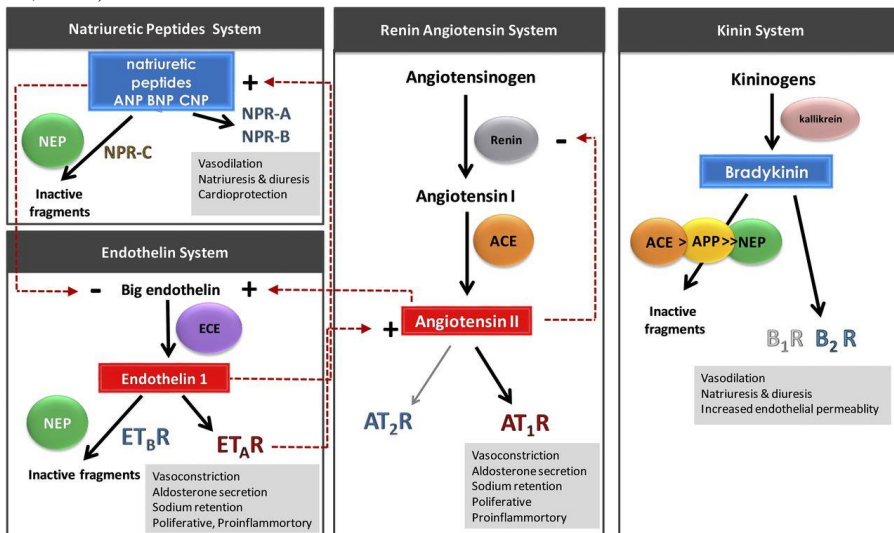
Angiotensinogen enters the course



**Figure 2.** Renin-Angiotensin System and associated peptides in hypertension

prevalently by liver creation, despite even though additionally made by different organs including the mind, resistant framework, and kidney show in figure 2. Changes in angiotensinogen levels in these tissues might impact the movement of neighborhood renin-angiotensin frameworks through instruments that are random to angiotensinogen levels in the flow. Angiotensin II, for instance, may improve angiotensinogen amalgamation in the proximal tubule of the kidney as a component of a nearby, intra-renal RAS that is controlled autonomously of the fundamental by RAS. This evident "feed-forward" framework could impact epithelial cell action along the nephron, improving salt reabsorption and hypertension. In patients with hypertension and different types of constant renal illness, pee angiotensinogen might be used to assess RAS initiation in the kidney(O'Shea et al., 2017).

**2.3 Atrial Natriuretic Peptide**

Atrial granules discharge atrial natriuretic peptide (ANP). It causes natriuresis, diuresis, and a little drop in pulse, while additionally bringing down plasma renin and aldosterone levels. Osmoreceptor synaptic transmission is additionally impacted by natriuretic peptides. The feeling of atrial stretch receptors causes the arrival of ANP. Raised filling tensions and people with

blood vessel hypertension and passed on ventricular hypertrophy to improve ANP focuses on the ground that the left ventricle divider adds to ANP discharge(Fu et al., 2018).

**2.4 Eicosanoids**

Arachidonic corrosive metabolites influence pulse by impeding the autonomic sensory system, the renin-angiotensin-aldosterone framework, and other humoral pathways through direct consequences for vascular smooth muscle tone and communications with other immense administrative frameworks. Vascular endothelial cell disappointment in hypertension people might bring about a reduction in endothelium-inferred loosening up factors like nitric oxide, prostacyclin, and endothelium-determined hyperpolarizing factor, as well as an expansion in contracting factors like thromboxane A2 and endothelin-1(Gronda et al., 2020).

**2.5 Kallikrein-Kinin Systems**

Vasoactive peptides are formed when tissue kallikreins interact with kininogen. The vasodilator bradykinin is the most important. Kinins are involved in the regulation of renal blood flow, as well as the excretion of water and sodium. ACE inhibitors prevent bradykinin from being broken down into inactive peptides (McCarthy et al., 2021).

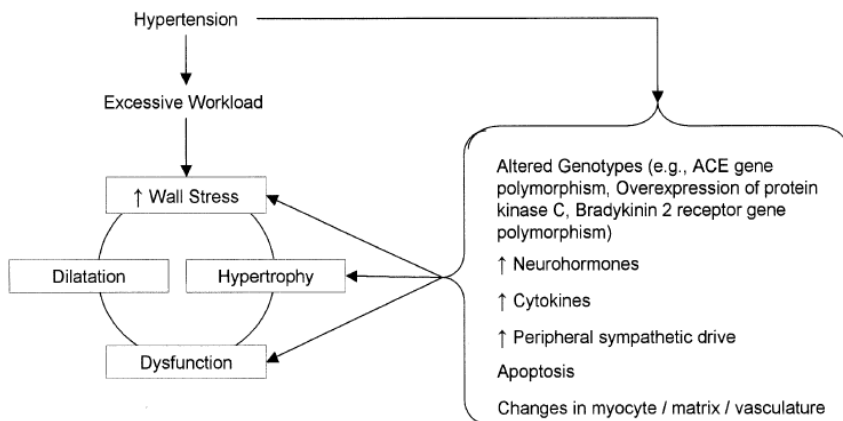**2.6 Endothelial System**

The vasodilation caused by



**Figure 3.** Mechanism of action of cardiac hypertrophy in hypertension

bradykinin, acetylcholine, nitrates and sodium nitroprusside is controlled by nitric oxide. In individuals with hypertension, endothelial-mediated relaxation is reduced. The endothelium produces the most potent vasoconstrictors, endothelins. The production and awareness of endothelin-1 are similar in hypertensive and normotensive persons. Nevertheless to hypertensive endothelial damage, the vascular effects of endothelin-1 endogenous may be exacerbated by decreased nitric oxide production. (Konukoglu et al. , 2016).

**2.7 Adrenal steroids**

Glucocorticoids and mineralocorticoids increase heartbeat. Enhanced vascular response or salt and water retention can counteract this impact. In addition, both increase vascular tone by activating pressor chemical receptors such as angiotensin-2 (Lightman et al., 2008).

**2.8 Renomedullary Vasodepressor**

Medullipin I is discharged by adrenomedullary interstitial cells, which are generally found in the renal papilla. This lipid is changed over to medullipin II in the liver. This medication has a dependable hypotensive effect, which might be because of direct vasodilation, a decrease of thoughtful drive in light of hypotension, and a diuretic impact. The movement of the adrenomedullary framework is believed to be constrained through the renal medullary bloodstream (Abe et al., 1977).

**2.9 Sodium & Water Discharge**

An expansion in the pulse is connected to sodium and water maintenance. It is felt that sodium delivers an expansion in intracellular calcium in the major cell-like; vascular single and multi-unit smooth muscle, bringing about higher vascular activity, through the calcium-sodium trade process. An inappropriate connection among tension and sodium discharge brought about by diminished renal bloodstream, lower nephron mass, and raised angiotensin or mineralocorticoids might be the significant reason for salt and water maintenance (Shuang et al., 2019)**.**

# 3 Hypertension and Left Ventricular Remodeling

The most prevalent cause of LVH is systemic hypertension, which causes a continuous increase in workload on the left ventricle. In vivo, this structural alteration can be detected using an ECG or echocardiography. Expanded adequacy, width, and indenting of the QRS intricate left pivot deviation, repolarization (ST-T wave) changes, and LA anomalies are largely indications of LVH. Albeit the specificities of a few ECG rules for the analysis of LVH, for example, the Sokolow-Lyon, Romhilt-Estes, and Cornell voltage rules are for the most part high (above 90%), their awarenesses range from 7% to 60%. The awareness of the ECG standard is changed by both biologic (stoutness and cigarette smoking diminish responsiveness) and methodologic factors (age and seriousness of LVH upgrade awareness) (expanded when LV mass was ordered to body surface region rather than tallness). Mechanism of action of cardiac hypertrophy in hypertension show in figure 3. Quantitative echocardiography has shown to be a more solid and accurate proportion of chamber mass, divider thickness, and plan during the most recent 20 years, giving a repeatable strategy for painless assessments of ventricular engineering. Just 1.3 percent of the people in a new Framingham research displayed affirmed LVH by ECG measures, although 19% of men and 24 percent of ladies met the echocardiographic standards for LVH (Bornstein et al., 2021).

# 4 Pathophysiological Underpinnings of Hypertension

1. Expanded sensory system action
2. Surplus of sodium-holding chemicals

3. Vasoconstrictor drugs
4. Excessive sodium consumption for a long time
5. Expanded or improper renin emission
6. Lacks of sodium-holding chemicals and vasoconstrictors
7. Varieties in articulation of the kallikrein-kinin framework
8. Diabetes mellitus and obesity
9. Pulse, inotropic attributes of the heart, and vascular tone are totally impacted by changes in adrenergic receptors, as well as changed cell particle transport (Daiber et al., 2019).

**4.1 Pathophysiology of Hypertension**

Continuously pulse amplification that harms end organs in addition to increasing morbidity and mortality is called hypertension. Blood pressure is the primary vascular resistance and cardiovascular outcome. Individuals with hypertension may therefore have a rise in cardiac yield, underlying vascular blockage or both. The heart yield is much of the time improved in more youthful patients, while in more established patients, expanded vasculature firmness and expanded fundamental vascular obstruction play a significant effect. Expanded-adrenoceptor initiation or expanded arrival of peptides such as endothelins or angiotensin can deliver an expansion in vascular tone. In the last step, calcium in the vascular smooth muscle promotes vasoconstriction. A few maturation chemicals, such as endothelins and angiotensin, which promote an increase in vascular smooth mass, are responsible for the vascular remodelling. Due to an increase in both vascular stiffness and basic vascular blockage, the layer on the left ventricle grows, resulting in hypertrophy of the left ventricle and diastolic instability. Young people have relatively low left ventricular blood pressure, and the waves echoed by peripheral blood vessels primarily occur after systole ends. This causes the early portion of diastole to be more stressful and improves heart perfusion. The aorta's hardening and flexible passageways widen the pulse pressure as we age. Early diastole gives way to late systole in reflected waves. This contributes to left hypertrophy and increases left ventricular afterload. Growing older and experiencing an enlarged heartbeat is a strong sign of coronary heart disease (Beevers et al., 2001).

The circulatory strain guideline engages the autonomic sensory system. Patients with hypertension have been shown to exhibit both increased fringe sensitivity to norepinephrine and increased norepinephrine discharge. Furthermore, there is an additional notable resistance to upsetting upgrades. There are two distinct features of blood vessel hypertension: the baroreflexes being reset and the baroreceptors being less sensitive. In the presence of essential hyperaldosteronism, the renin-angiotensin system is inhibited and is linked to at least some forms of hypertension, such as renovascular hypertension. People of color tend to have low-renin hypertension more often. Others are more likely to experience cardiac dead cells and other cardiovascular problems because they have high-renin hypertension (Kur et al., 2012).

In human primary hypertension and trial hypertension, the volume link between pulses and sodium excretion is hindered. Evidence suggests that one of the key factors contributing to the management of hypertension is the restoration of pressure natriuresis. In individuals with fundamental hypertension, the resetting of strain natriuresis is characterized by a reduction in the slope of pressure natriuresis and salt-related hypertension, or by an equal shift towards more serious hypertension (Kario et al., 2014).

# 5 Management of Hypertension
**5.1 Prevention of Hypertension**

*5.1.1 Eating a healthy diet in routine:* Limit how much sodium (salt) you consume and build how much potassium

**Table 1** Herbs used in Management of Hypertension

| Herbs | English Name | Concentration/ Dose | References |
|---|---|---|---|
| *Allium sativum* | Garlic | 3mg/ml | (Al Disi, Anwar, & Eid, 2016) |
| *Andrographis paniculata* | King of Bitter | 0.7-2.8g/kg | (Al Disi et al., 2016) |
| *Apium graveolens* | Celery | 1ml/kg | (Al Disi et al., 2016) |
| *Camellia sinensis* | Tea | 5g/kg | (Al Disi et al., 2016) |
| *Coptis Chinensis* | Goldthread | 150mg/kg | (Al Disi et al., 2016) |
| *Coriandrum sativum* | Coriander | 200mg/kg | (Al Disi et al., 2016) |
| *Crocus sativus* | Saffron | 20-80mg/kg | (Al Disi et al., 2016) |
| *Hibiscus sabdariffa* | Roselle | 2mg/ml | (Al Disi et al., 2016) |
| *Zingiber officinale* | Ginger | 0.05mg/ml | (Aiyeloja & Bello, 2006) |
| *Cymbopogon citratus* | Lemongrass | 100 mg/kg | (Aiyeloja & Bello, 2006) |
| *Nigella sativa* | Black Cumin | 0.6 ml/kg/day | (Aiyeloja & Bello, 2006) |
| *Salviae miltiorrhizae* | Chinese Sage | 5 g/twice a day | (Aiyeloja & Bello, 2006) |

is in your eating regimen to assist with dealing with your circulatory strain. Eating low-fat food varieties, as well as an adequate number of organic products, vegetables, and entire grains, is likewise useful. The DASH eating plan is an illustration of an eating regimen that can support pulse decrease.

*5.1.2 Getting regular activity:* Exercise can assist you with keeping a sound load while likewise bringing down your circulatory strain. Something like 2 and 30 minutes of moderate-power high-impact movement, or 1 hour and 15 minutes of lively for oxygen-consuming activity, should be finished every week. Any activity that makes your heart beat faster and your body consume more oxygen than expected is delegated vigorous activity.

*5.1.3 Maintaining a solid weight:* Obesity or being overweight raises yotheospossibility hypertension. Keeping a sound weight can support the administration of hypertension and the counteraction of other wellbeing concerns.

*5.1.4 Drinking with moderation:* Too much liquor could cause your circulatory strain to rise. It additionally adds more calories, possibly prompting weight gain. Men should restrict themselves to two beverages every day, while ladies should restrict themselves to one.

*5.1.5 No smoking:* Cigarette smoking lifts circulatory strain and builds your gamble of coronary failure and stroke. Try not to begin smoking on the off chance that you don't as of now. Assuming you smoke, talk with your medical care doctor about the best strategy to stop.

*5.1.6 Dealing with pressure:* Learning to unwind and oversee pressure can assist you with feeling far improved genuinely and truly, as well as lower your circulatory strain. Working out, standing by listening to music, zeroing in on something quiet or peaceful, and pondering are for the most part

compelling pressure the executives draws draw (Diaz et al., 2013).

**5.2 Nutritional Factors in Hypertension Management**

In the treatment of hypertension, dietary changes play a fundamental part. Solid information backs up the suggestion of a potassium-rich, moderate-liquor, and high-fiber diet. All in all, a DASH design diet wealthy in , vegetables, entire grains, natural products, low-fat dairy items, fish, nuts, sugar-improved food, drinks and fats as well as wealthy in vegetables and products of the soil in creature protein, ought to be investigated. It isn't prescribed to utilize drug enhancements to accomplish these dietary objectives. Proficient associations, by and large, empower sodium limitation; by and by, given the proof of related expected adverse consequences and its shifted adequacy in different patient populaces, this ought to be painstakingly perceived and custom-made. As far as expanded calcium, magnesium, fish oil, and garlic consumption, the solution is ambiguous. Unpredictable espresso consumers and licorice clients have a higher possibility creating hypertension; consequently these propensities ought to be stayed away from high-risk patients (Nguyen et al., 2013).

**5.3 Herbs used in Management of Hypertension**

Table I shows the herbs used in the management of hypertension.

**5.4 Classes of Drugs for the Management of Blood Pressure**

• Beta-blockers
• Alpha-blockers
• ACE inhibitors
• Calcium channel blockers
• Diuretics
• Angiotensin II receptor blockers
• Central agonists
• Vasodilators

*5.4.1 Diuretics*

Diuretics aid in the removal of excess water and salt from the human body in addition to the regulation of pulse. They frequently go together with other drugs that have been prescribed by doctors (Hermida et al., 2016).

**Table 2** Diuretic medications

| Generic Name | Common Brand Name |
|---|---|
| Furosemide | Lasix. |
| Bumetanide | Burinex |
| Spironolactone | Aldactone |
| Hydrochlorothiazide | Aquazide |
| Amiloride | Midamor |

*5.4.2 Beta-blockers*

Beta-blockers lower the pulse by bringing down the pulse, exertion, and blood result of the heart (Hermida et al., 2016).

**Table 3** Beta-blocker medication

| Generic Name | Common Brand Name |
|---|---|
| Acebutolol | Sectral |
| Oxprenolol | Tractor |
| Pindolol | Visken |
| Bisoprolol | Concor |
| Celiprolol | Edsivo |

*5.4.3 ACE inhibitors*

Angiotensin is a hormonal substance that causes artery narrowing, mostly in your kidneys but also in other parts of the body. The peptide known as angiotensin-converting enzyme changes angiotensin-I into angiotensin-II. By assisting the body in producing less ACE assist the blood vessels relax and open up, decreasing blood pressure (Hermida et al., 2016).

**Table 4** ACE inhibitors medication

| Generic Name | Common Brand Name |
|---|---|
| Imidapril | Hipertene |
| Captopril | Capoten |
| Zofenopril | Zocardis |
| Cilazapril | Inhibace |
| Ramipril | Altace |

*5.4.4 Angiotensin II receptor blockers*

Angiotensin-changing over chemical inhibitors (ACEIs) block the impacts of angiotensin, a substance that makes supply routes restricted. To contract a

vein, angiotensin requires a receptor-a substance "opening" to squeeze into or bond with. Angiotensin-changing over compound inhibitors (ARBs) block receptors, keeping angiotensin from tightening veins(Hermida et al., 2016).

**Table 5** Angiotensin II receptor blockers medication

| Generic Name | Common Brand Name |
|---|---|
| Candesartan | Atacand |
| Telmisartan | Micardis |
| Irbesartan | Avapro |
| Losartan potassium | Cozaar |

*5.4.5 Calcium channel blockers*

This medication inhibits the entry of calcium into the heart and smooth muscle cells in conduits. In these areas, calcium provides a more notable and robust compression as a result, adding calcium leads the heart to contract less forcefully. Calcium channel blockers relax and widen constricted veins, lowering heart rate and blood pressure (Rothwell et al., 2010).

**Table 6** Calcium channel blocker medication

| Generic Name | Common Brand Name |
|---|---|
| Isradipine | Dynacirc, |
| Nifedipine | Adalat cc |
| Nisoldipine | Sular |

*5.4.6 Alpha-blockers*

These drugs lower artery resistance by loosening up the blood vessel dividers' solid tone(Bittar et al., 1995).

**Table 7** Alpha-blockers medication

| Generic Name | Common Brand Name |
|---|---|
| Terazosin hydrochloride | Hytrin |
| Doxazosin mesylate | Cardura |
| Prazosin hydrochloride | Minipress |

*5.4.7 Central agonists*

Focal agonists additionally help to diminish the capacity of veins to tense or contract. Focal agonists work through an unexpected neuronal pathway in comparison to alpha and beta-blockers, yet they all work to bring down the pulse(Bittar et al., 1995).

**Table 8** Central agonists medication

| Generic Name | Common Brand Name |
|---|---|
| Rilmenidine | Albarel |
| Methyldopa | Hypergen |
| Clonidine | Catapres |
| Guanfacine hydrochloride | Tenex |

*5.4.8 The vasodilators*

Vasodilators, also known as blood vessel dilators, cause the arterioles and other blood vessel walls to relax, causing the vessel to broaden . Blood flows more easily as a result of this (Bittar et al, 1995).

**Table 9** Blood vessel dilators medications

| Generic Name | Common Brand Name |
|---|---|
| minoxidil | Loniten |
| hydralazine hydrochloride | Apresoline |

# 6 Conclusion

Various epidemiological examinations like Framingham Heart Study in 1948 and proceeding to the current day, have shown the risks related to hypertension. Hypertension is associated with left ventricular hypertrophy, cardiovascular breakdown, fringe vascular sickness, end-stage renal illness, cardiovascular diseases and carotid atherosclerosis. Multiple studies have demonstrated that treating hypertension in the elderly is not only safe, but significantly reduces the risk of stroke, heart failure, myocardial infarction, and death. Established dietary guidelines and some herbs have been shown to help lower blood pressure and, as a result, hypertension-related

comorbidities and overall mortality. More research on the impact of nutrients, counselling and herbal medications in preventing and treating hypertension complaints in unique populations is needed.

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