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Effect of compositional *allicin* in garlic bread supplementary diet on patients of stage 1 and 2 hypertension

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Abstract

Prevalence of hypertension is 26 % globally and expected to increase by 29 % till 2025, while in Pakistan its rate is 35 % due to genetic susceptibility, gender, urbanization and secondary life styles in middle ages, which causes heart diseases and stroke. It is the 1st and 3rd dominant cause of death worldwide. Non-pharmacological medication such as use of garlic in diet to reduce hypertension is the main goal in this study. As the bioactive sulfur compound source, garlic consists of *S-Allylcysteine*. Garlic-derived polysulfide triggers the production of vascular gasotransmitter hydrogen sulphide (H_2S) and improves the regulation of endothelial nitric oxide (NO) which encourages smooth muscle relaxation, vasodilatation and blood pressure (BP) reduction. This randomized control study was planned to conclude the effect of garlic bread supplementary diet (GBSD) product on BP in patients with hypertension stage 1 and 2. In total, 2 patients with stage 1 hypertension and 2 with stage 2 hypertension were prescribed with a daily dose of GBSD (containing 600 mg garlic powder n=1 and n=1, respectively) or placebo (n=1 and n=1, respectively) for 12 weeks, were allocated to efficacy analyses. Systolic and diastolic blood pressure values were checked at weeks 4, 8 and 12. During the intervention an eloquent decline of systolic and diastolic BP within the range of 19.5-18.5 and 14.4-13.5 mmHg, respectively compared to placebo specifically during 8 and 12 week, obtained. GBSD was well tolerated, and had a clinically pertinent hypotensive effect in patients with stage 1 and 2 hypertension.

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Introduction

Hypertension is a noiseless killer, since it remains with no ostensible symptoms(Ford *et al.,* 2009)and became an obligatory world public health dilemma(Erem *et al.,* 2009), Hypertension, defined as systolic blood pressure BP>140 mmHg and a diastolic BP >90 mmHg, hypertension, stage 1 has systolic blood pressure ranging from (140-159 mmHg) and diastolic blood pressure ranging from (90-99 mmHg) while in stage 2 blood pressure range has been defined as (160-179 mmHg) and (100-109mmHg) for systolic and diastolic blood pressure, respectively(6th report of JNC *et al.,* 1997). It is one of the major risk factors for mortality and various cardiac morbidities, including stroke, coronary heart disease and kidney dysfunction (Kannel *et al.,* 1995). It has poignant an estimated 1 billion individuals worldwideand affects up to 30 % of the adult population in majority countries (Chobanian *et al.,* 2003). The number of people suffering from hypertension has been estimated to reach 1.56 billion by 2025 around the globe (Chokalingam *et al.,* 2007) which will be around 29 % of the worldwide adult population (Kearney *et al.,* 2005) and causing about 7 million deaths per annum (Fagard *et al.,* 2012).There is a dire need of raising awareness of hypertension prevalence and associated complexities because of the huge gap evident from the study of Abbas (Abbas *et al.,* 2009). The National Health Survey of Pakistan 2005 stated an alarming situation, mentioning about 18 % belonging to early adulthood and 33 % middle adulthood suffering from hypertension. Moreover, regardless of greater hypertension prevalence, less than 3 % presented controlled blood pressure (Jafar *et al.,* 2005).>50 % of hypertensive individuals were unaware of their condition (Chockalingam *et al.,* 2008). Only half of the people with hypertension received antihypertensive medication, however, 60 % of patients on treatment suffered with inadequately controlled BP (Briganti *et al.,* 2003). Hypertensive patients despite modern therapies need more than 2 drugs to manage blood pressure levels, owing to the worldwide rise in the incidence and socioeconomic burden of hypertension, it is unconditionally essential to find non pharmacological products which not only provide virtuous blood pressure control but also confirm to be innocuous and cost effective(Volpe *et al.,* 2010).Application of natural substances with hypotensive effect has arisen amongst the public because of their little adverse effects, low cost, accessibility without prescription and consultation to health professionals(Vora *et al.,* 2005).

Allium sativum L. known as garlic is usually used around the world for both esculent and curative intentions (Rahman *et al.,* 2001). Among the active elements in garlic, one dominant component is *allicin* (thio-2-propene-1-sulfinic acid S-allyl ester), which has arisen from the invariable prototype S-allyl cysteine-S-oxide (*alliin*) by the action of the enzyme *alliinase* when garlic cloves are crumbled or macerated(Okada *et al.,* 2006).*Allicin* has been proved to lower blood pressure in hypertensive patients and rats(Bhardwaj *et al.,* 2015; Elkayam *et al.,* 2013; Ali *et al.,* 2000; Elkayam *et al.,* 2001). García *et al.* (2016) stated that *allicin* treatment in rats with subtotal nephrectomy upgrades cardiac capacity and alleviates oxidative stress and hypertension (Garcia *et al.,* 2016).*Allicin* in garlic presented antibacterial and antioxidant competency when used as supplement, garlic is persuasive in treatment of hypertension because of *allicin*'s angiotensin II–restricting and vasodilating properties (Al-Qattan *et al.,* 2003; Sharifi *et al.,* 2003; Benavides *et al.,* 2007). Phenolic and steroidal combinations in garlic also have pharmacological effects (Lanzotti *et al.,* 2006). Garlic is valuable in treatment of hypertension recommended by numerous testimonies of human trials (Adler *et al.,* 1997; Sobenin *et al.,* 2009; Ried *et al.,*2010; Ried *et al.,* 2013; Nakasone *et al.,* 2013; Ashraf *et al.,* 2013). Still, the results from various preceding meta-analysis were antithetical, Silagy and Neil in 1994 concluded that garlic lowered BP in patients with mild hypertension after seven trials, Ackermann *et al.,* outlined the effects of garlic on assorted cardiovascular-related factors and found not any momentous effect on BP in their 2001 meta-analysis, Ried *et al.* (2008) found that garlic preparations were better than placebo in lowering BP in patients with

hypertension involved in a systematic review of 25 studies(Ackermann *et al.,* 2001, Ried *et al.,* 2008, Silagy and Neil *et al.,* 1994).

Allicin as organosulfur compound in garlic powder has BP lowering properties by arbitration of intracellular nitric oxide (NO) and hydrogen sulfide (H_2S) production as well as obstruction of angiotensin-II production, which promotes vasodilation and responsible in reduction of blood pressure (Morihara *et al.,* 2002, Sharifi *et al.,* 2003, Al-Qattan *et al.,* 2006, Benavides *et al.,* 2007, Chuah *et al.,* 2007, Shouk *et al.,* 2014). The mechanism of the BP-lowering result of *allicin* as displayed in pictorial view at the end of document involves endothelium-dependent vasodilatation, by concentrating on physiological and biochemical processes within blood vessels. endothelial nitric oxide synthase (eNOS)-derived NO encourages relaxation of smooth muscle cells and, thus, increased dilation of all types of blood vessels, via a guanylyl cyclase-dependent mechanism (Förstermann *et al.,* 2012). Lack of NO production by eNOS and H_2S deficiency as vasorelaxation signaling part is supposed to be a major contributory factor in the development of vascular dysfunction and hypertension (Panza *et al.,* 1995; Montezano *et al.,* 2012; Predmore *et al.,* 2012; Wang *et al.,* 2012; Kashfi *et al.,* 2013; Majzunova *et al.,* 2013; Zhang *et al.,* 2013). Regulation of NO redox signaling pathways, including NO-mediate also influenced by polysulphides present in garlic. Other potential mechanisms of action for *allicin* effect on hypertension have the potential of garlic blocking angiotensin-II production by inhibition of the angiotensin-converting-enzyme (ACE), as suggested in a number of cell culture and animal studies (Al-Qattan *et al.,* 2003; Sharifi *et al.,* 2003; Shouk *et al.,* 2014). ACE is a component in the renin–angiotensin–aldosterone system, and inhibitors of ACE are used as standard BP-controlling pharmaceuticals these animal and cell culture experiments were mainly conducted with fresh garlic compounds, containing *allicin* (S-allyl-cysteine sulfoxide), the antihypertensive effect of garlic via the proposed angiotensin converting enzyme inhibitor mechanism seems less plausible than its H_2S-stimulating and NO-regulating properties (Lawson *et al.*, 2005).

Several human trials have been carried out, with recent confirmations during past few years; therefore, we administered a case study for the following intentions: (1) to update the testimony on the association between garlic intake and BP, (2) to analyze this association according to dosage's duration. Keeping in mind the booming attraction in substitute therapies for hypertension, the effects of garlic powder (600 mg/day) by adding into bread in the form of garlic bread supplementary diet (GBSD) for stage 1 and stage 2 hypertensive patients, were analyzed during a 12 week treatment period.

Research methodology

Materials

Garlic powder, whole wheat flour, instant dry yeast and caster sugar were purchased from the local market of Faisalabad-Pakistan. Sphygmomanometer (HEM-705IT) was purchased from Omron Crop., Kyoto, Japan.

Composition of ingredients

Composition of raw materials was determined through methods explained in AOAC, 2010 and compared with standard composition of garlic powder from Shandong Xinnuo Food Technology Co. Ltd. (China), stored at -18 degree, whole wheat flour from ALK Trading LLC (Ukraine), instant dry yeast from Heze Duomei Yeast Co.,Ltd. (China) while caster sugar composition was taken from Mitr Phol Sugar Corp.,Ltd. (Thailand).

Patients and inclusion criteria

4 patients were divided into two groups, group one was stage 1 hypertensive group having systolic blood pressure (140-159 mmHg) and diastolic blood pressure (90-99 mmHg) while group 2 was stage 2 hypertensive group with systolic blood pressure (160-179 mmHg) and diastolic blood pressure (100-109 mmHg) (JNC 6th report *et al.,* 1997). Patients with chronic renal failure, cardiac dysfunction, diabetes, or

allergic to garlic bread and placebo ingredients were excluded, similarly if using any antihypertensive treatment or blood pressure lowering medications, or pregnant, nursing, child bearing potential women were also rejected. From all patients written informed consent was taken. Patients' medical and lifestyle histories, laboratory tests and measurement of BP were taken in 2 screening visits at an interval of 2 weeks after that study treatment was administered. Patients were categorized into these stages after BP measurement in visit 1 and 2 that matches the defined ranges of hypertensive stages and were again confirmed their allotted stages by measuring their BP during 2 weeks between visit 2 and 3.

Study design

Randomized control study was planned to evaluate the productiveness of GBSD for reduction of BP in registered patients in contrast to placebo. The run-in period of study was 4 weeks for screening and 12 week treatment period. It was completed in between 1stFebruary, 2019 to 24th May, 2019.

GBSD and placebo diet

Garlic bread supplementary diet (GBSD) used in this study was prepared consisting of 2400mg garlic powder, 500g of wheat flour, 6-7 gram of instant yeast and 2 teaspoons of caster sugar by making dough and baking the bread in Sargodha medical college nutrition laboratory (Sargodha, Pakistan). It contains 4 serving sizes and each serving of bread consists of 2 slices containing 600mg of daily dose of garlic powder required to reduce blood pressure (Auer *et al.,* 1990). Placebo was plain bread not containing garlic powder and similar in appearance to garlic bread.

Study diary

It was necessary for each patient to keep a diary of their bread intake, any antagonistic events experienced, dietary composition, all received medications and therapies (Nakasone *et al.,* 2013). They were accustomed to care for their body weight and refrain from exercising, eating or drinking in excess from usual intake. They were assigned to their coded study group with 1 servings of bread (2 slices) per day at any time. Laboratory test, physical parameters, BP measurements were taken at baseline (visit 3), week 4 (visit 4), week 8(visit 5) and week 12 (visit 6).

Demographic and dietary composition

Anthropometric measurements of all patients were taken considering gender and age, BMI (weight/height (m^2) was calculated by using height and weight. Dietary composition contained total energy (kcal), carbohydrate, protein and fat intake of patients which was calculated by study diary (Nakasone *et al.,* 2013).

BP evaluation

An automated sphygmomanometer (HEM-705IT; Omron Crop., Kyoto, Japan) was used to measure BP from the left arm. Measurements were carried out repeatedly (a maximum of 6 times) at 3 minutes interval following a 12 minutes rest in sitting position until the difference of 2 measurements was <6 mmHg the mean value was used as final result.

Blood chemistry analysis

By venipuncture, fasting blood samples were taken at every clinical visit. The EDTA tubes were urgently refrigerated and within 2 hour centrifuged. In frozen state plasma samples were stored. Samples were analyzed by following hematological and biochemical criteria. Fluorometric-enzymatic assay is based on an enzyme-coupled reaction for determining free cholesterol, HDL cholesterol and LDL cholesterol. Cholesterol esterase is used to convert esterified cholesterol into cholesterol. Ketone products, hydrogen peroxide and cholest-4-en-3-one were produced by action of cholesterol oxidase on resulting cholesterol. Fluorescence probe was used to detect hydrogen peroxide (Allain *et al.,* 1974; Amundson *et al.,* 1999; Dos Santos *et al.,* 2015) to detect fasting glucose in laboratory enzyme hexokinase (HK) method. HK acts to catalyze the reaction to form glucose 6 phosphate (G-6-P) and adenosine diphosphate (ADP) from glucose and adenosine triphosphate (ATP). Glucose 6 phosphate

dehydrogenase enzyme was used to oxidize G-6-P to 6-phosphogluconate and reduce nicotinamide adenine dinucleotide (NADH) in the presence of nicotinamide adenine dinucleotide (NAD). Glucose concentration is directly proportional to increase in NADH concentration and measured at 340nm spectrophotometric ally (Barthelmai W *et al.,* 1962; Method of glucose *et al.,* 1976; Henry JB *et al.,* 1979).

The triglycerides method used, was introduced by Van Handel Zilversmit (Handel *et al.,* 1957). For HbA1c determination chromatographic assay method was used in which by HPLC instrument and ion exchange or affinity column HbA1c molecules were separated from hemoglobin molecules (Hamwi *et al.,* 1995; Camargo *et al.,* 2004).

Coating

Patients including analysts were blinded to treatment in the whole period of study because placebo is identical in presentation and volume to garlic bread supplementary diet. Study diary (Nakasona *et al.,* 2013) was analyzed in each visit to inspect the blinding of patients, efficacy of blinding and tolerance of studied GBSD.

Intervention tolerability

Tolerability reporting included if there was an occurrence and asperity of treatment related unfavorable events that patients experienced in whole treatment.

Results and discussion

Composition of raw materials has been displayed in Table 1. representing maximum ash in garlic powder followed by instant dry yeast, the proximate composition of garlic powder used in current study was found in accordance with the research done by Mariam *et al.* (2016) who reported that carbohydrates, fat, protein and ash content of the garlic powder per 100 g as 66.33, 0.51, 19.75 and 5.09 (%) respectively (Mariam *et al.,* 2016).

Table 1. Composition of raw ingredients.

Ingredients	Moisture (%)	Ash (%)	Carbohydrate (%)	Protein (%)	Fat (%)	Crude Fiber (%)
Garlic powder	6.8	5.09	66.33	19.75	0.51	1.52
Wheat flour	16	0.78	57.02	11.9	2.3	12
Instant dry yeast	-	5.01	34.52	41	0.56	18.91
Caster sugar	0.04	0.02	99.94	-	-	-

The chemical composition of instant dry yeast used in current study was found in accordance with research done by Ahmad *et al.* (2011) who had summarized the results of chemical composition of instant dry yeast as carbohydrate, fat, protein and ash content of instant dry yeast per 100 g as 34.52, 0.56, 41 and 5.01 (%) respectively (Ahmad *et al.,* 2011). Maximum carbohydrates were observed in garlic powder followed by wheat flour, the nutritional composition of wheat flour used in current study was found in accordance with the research done by Kumar *et al.* (2011) who had reviewed the nutritional contents and medicinal properties of wheat and he mentioned the carbohydrates, fat, protein and ash content of the wheat flour per 100 g as 57.02, 2.3, 11.9 and 0.78 (%) respectively (Kumar *et al.,* 2011), compositions of ingredients were found compatible with standards available online.

Traits of subjects

Patients were included in the study maintaining gender equality, who represented age range from 47 to 54 (years), weight and height ranging from 62 to 68 (kg) and 64 to 65 (inches) respectively, while BMI ranged from 23 to 25. In total, 4 patients were included, and were administered to grouping placebo and GBSD as per category of hypertension stages 1 and 2. A total of 4 patients completed all the clinical visits and were managed to efficacy analysis. Table 2 shows the baseline characteristics of the patients. In each patient there were no significant differences between the placebo and GBSD groups.

Table 2. Baseline characteristics of the subjects.

	Stage 1 hypertension		Stage 2 hypertension	
Parameter	Placebo	Intervention GBSD	Placebo	Intervention GBSD
Age(years)	47	53	53	54
Gender	Female	Male	Male	Female
Weight(kg)	64	68	64	62
Height(inches)	65	64	65	65
Body mass index(kg/m²)	24	25	25	23
Systolic/diastolic BP(mmHg)				
Measured at clinical visit	145/93	149/95	168/103	172/105
Measured at home	148/95	151/96	170/102	175/105
Blood chemistry				
LDL-cholesterol(mg/dl)	128	132	124	130
HDL-cholesterol(mg/dl)	61	71	69	72
Triglyceride(mg/dl)	124	117	122	119
Fasting glucose(mg/dl)	94	94	93	92
HbA1c (%)	5.1	5.1	5.1	5.1
Dietary composition				
Total energy(kcal/day)	1738	1911	1860	1740
Total protein(g/day)	62	70	71	64
Total fat(g/day)	57	69	65	52
Total carbohydrate(g/day)	250	245	230	247

(GBSD, garlic bread Supplementary diet; BP, blood pressure).

Table 2 also showed that the mean baseline levels of all physical and biochemical parameters, with the exception of systolic and diastolic blood pressure, for the two groups were within the normal ranges regarding clinical measurements.

Impact on BP parameters

The changes in the mean value of the systolic and diastolic BP over the 12-week treatment period are shown in Table 3. In Stage 1 hypertensive patient there was a significant reduction in systolic BP from the baseline figure at week 4, 8 and 12 of GBSD treatment which was recorded as a decrease of 6 mmHg in each week, and in stage 2 hypertensive patient by taking GBSD there was similar level of reduction in systolic BP as observed in Stage 1 hypertensive patient from baseline to week 12, while no significant reduction was noticed at any time following the intake of the placebo in both stages. The values of diastolic BP in the stage 1 hypertensive patients, which were being fed with the GBSD treatment during the study period significantly lowered by 5 mmHg when compared with the baseline at week 4, 8 and 12. Similar level of reduction was observed with GBSD treatment in stage 2 hypertensive patients and no significant reduction observed in the placebo group in both stages. Several studies have proposed the BP lowering effects of garlic, all positive result studies were performed using hypertensive patients (systolic BP, ≥ 140 mmHg) (Kandziora *et al.,* 1988; Vorberg *et al.,* 1990; De A Santos *et al.,* 1993; Sobenin *et al.,* 2009)and all negative studies used normotensive subjects (systolic BP,<140 mmHg) (Jain *et al.,* 1993; Isaacsohn *et al.,* 1998; Zhang *et al.,* 2001, Williams *et al.,* 2005; Macan *et al.,* 2006). Considering these current positive reports, the present study of a new garlic-based supplementary diet (GBSD), exhibits that it

significantly reduced systolic and diastolic blood pressure in stage 1 and 2 hypertensive patients following 8 and 12-week treatments. As the BP reaches normal values the pharmacological phenomenon with certain antihypertensive medications have less effect. The BP-lowering effects of garlic and its preparations, in hypertensive patients have been recommended by two meta-analyses (Reinhart *et al.,* 2008, Ried *et al.,* 2008). Chobanian *et al.* (2003) and Julius *et al.* (2006) mentioned that there were non-significant BP reducing effects of garlic in Stage 1 and 2 hypertensive patients during short-term (12-week) treatment(Chobanian *et al.,* 2003; Julius *et al.,* 2006).

Table 3. Changes in systolic and Diastolic BP measured over the 12-week treatment period in stage 1 and stage 2 hypertensive Patients.

	Stage 1 Hypertension				Stage 2 Hypertension			
	Systolic BP(mmHg)		Diastolic BP(mmHg)		Systolic BP(mmHg)		Diastolic BP(mmHg)	
Time	Placebo	GBSD	Placebo	GBSD	Placebo	GBSD	Placebo	GBSD
Baseline	145	149	93	95	168	172	103	105
Week 4	144	143	92	90	165	166	102	101
Week 8	143	137	93	85	167	160	103	97
Week 12	145	131	92	81	167	153	103	91

(Baseline values were determined immediately prior to the start of treatment. GBSD, garlic bread supplementary diet; BP, blood pressure).

The results acquired from the stage 1 hypertensive patient groups in the present study appear to be in consent with those from earlier positive placebo-controlled analysis professed the significant hypotensive effects of conventional garlic preparations, mainly dried garlic powder products, in individuals who had mild or moderate hypertension(Kandziora *et al.,* 1988; Vorberg *et al.,* 1990; Auer *et al.,* 1990; De A Santos *et al.,* 1993; Jain *et al.,* 1993; Isaacsohn *et al.,* 1998; Sobenin *et al.,* 2009). Several meta-analyses of placebo controlled interventions displayed evaluating the efficacy of commercial and traditional dried garlic powder products having daily doses of 600-900 mg in the treatment of high BP, disclose reductions in systolic BP and diastolic BP of 7-16 and 3-9 mmHg, respectively (Auer *et al.,* 1990; Ackermann *et al.,* 2001; Reinhart *et al.,* 2008).

The results of the present study 12-week intake of GBSD, in a daily dose of 600 mg as garlic powder in bread, showed decreases of 18.5-19.5 mmHg and 13.5-14.5 mmHg from the baseline or placebo in systolic and diastolic blood pressure, respectively, in patients with stage 1 and stage 2 hypertension (Auer *et al.,* 1990). Therefore, the hypotensive effects of the GBSD do not emerge to be dissimilar to those reported for dried garlic powder products.

The findings of the present study on the hypotensive effects of the GBSD would have beneficial association with health where a reduction of 18.5-19.5 mmHg in systolic BP and 13.5-14.5 mmHg in diastolic BP has been estimated to reduce the risk of cardiovascular morbidity and mortality by 8-20 % (Mclnnes *et al.,* 2005).

The mechanisms of the hypotensive action of the GBSD in previous animal and in-*vitro* studies showed that GBSD diet and its major sulfur-containing constituent, γ-glutamyl-S-allyl-cysteine (GSAC), are able to lower BP in hypertensive rats(Tanaka *et al.,* 2006). Induction of endothelium-dependent and independent relaxation of the isolated rat aorta and the activities required to inhibit angiotensin I-converting enzyme (ACE) (Watabe *et al.,* 2006; Tanaka *et al.,* 2012). Effect of the GBSD in patients with high BP leads to recognition of the possibility that GSAC with its ACE-inhibitory and vasodilating activities may play a major role.

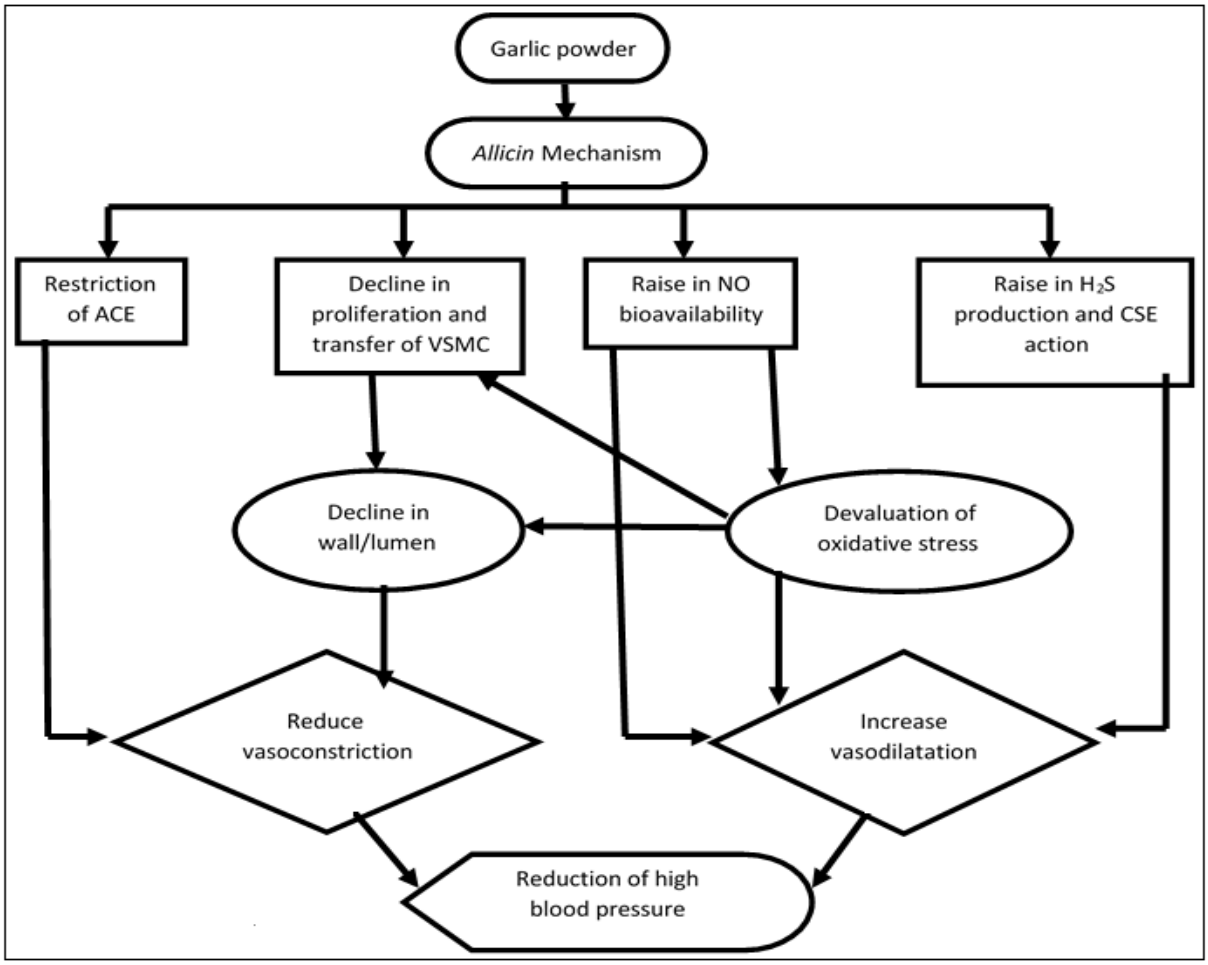

Fig. 1. Mechanism of action.

Blood chemistry

It was estimated through baseline data collection that in stage-1 hypertensive patient's total LDL-cholesterol, HDL-cholesterol, triglycerides, fasting glucose level was 128 & 132 (mg/dL), 61 & 71 (mg/dL), 124 and 117 (mg/dL), 94 (mg/dL) while HbA1c was 5.1 % (Table 2). In stage- 2 hypertensive patient's LDL-cholesterol, HDL-cholesterol, triglyceride, and fasting glucose level was 124 & 130 (mg/dL), 69 & 72 (mg/dL), 122 & 119 (mg/dL), and 93 & 92 (mg/dL) while HbA1c was 5.1 %. A large number of randomized, double-blind placebo-controlled trials for lowering blood levels of total cholesterol and/or LDL-cholesterol with attention to the potential of preparing the dried garlic powder, mixed results were observed in a systematic review by Turner *et al.* (2004) and a meta-analysis by Khoo and Aziz (Khoo and Aziz *et al.,* 2009). Long term trial is required for determining beneficial effects of GBSD on blood cholesterol.

Food intake

Stage 1 hypertensive patients food intake included total energy 1738 and 1911 (kcal/day), while total protein was 62 and 70 (g/day), total fat 57 and 69 (g/day) and total carbohydrate as 250 and 245 (g/day) in diet. Stage 2 hypertensive patients' food intake included total energy 1860 and 1740 (kcal/day) while total protein 71 and 64 (g/day), total fat 65 and 52 (g/day) and total carbohydrate as 230 and 247 respectively (Table 2).

Intervention tolerability

The incidence and sequence of adverse events that occurred in the 12 week treatment period in the GBSD group were identical to the placebo group. The most common was being in gastric distress, less frequent adverse events included headaches and abdominal pain with diarrhea (1 event in the GB group and 1 in the placebo group). All these were self-recorded, mild in intensity, temporary and unrelated to treatment.

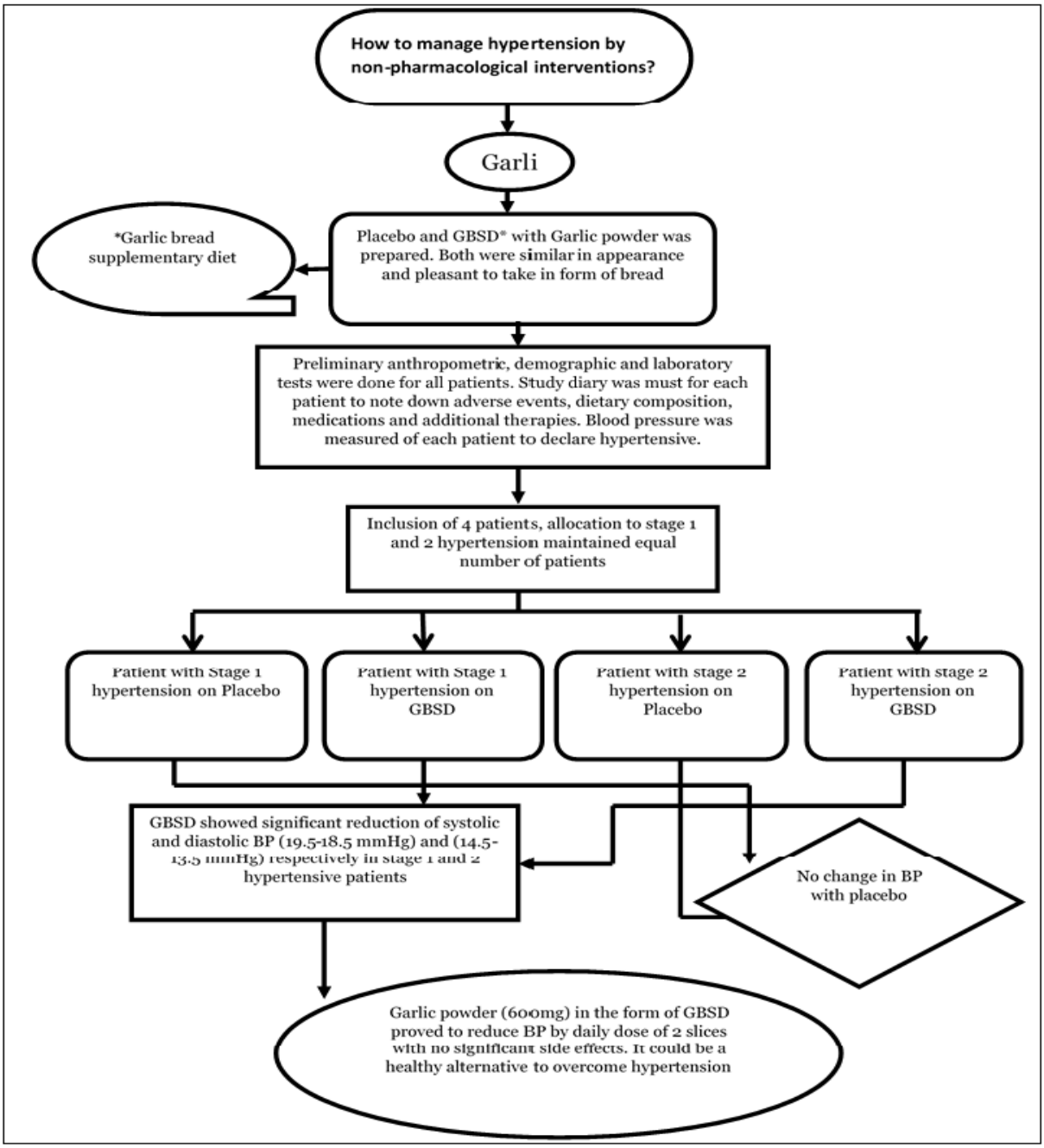

Fig. 2. Comprehensive flow diagram of study.

GBSD group patients did not report any garlic taste, garlic breath and any unpleasant body odor. GBSD treatment had no side effects and was safe with a wide range of doses. Garlic odor on the breath and body termed as a more frequent complaint next being mild gastrointestinal adverse events including nausea, bloating and flatulence (Borrelli *et al.,* 2007).

Comprehensive View

A comprehensive view of whole study can be seen at end.

Conclusion

In conclusion, the results of the present study showed that none of the subjects who were treated with the GBSD reported intolerable garlic odor or any other side-effect. Incorporation of garlic powder in bread may contribute to the tolerability, pleasant taste and easy to intake of the GBSD. The results of the present study have demonstrated that a daily 600-mg as GBSD lowered systolic BP by 18.5-19.5 mmHg and diastolic BP by 13.5-14.5 mmHg in patients with stage 1 and 2 hypertension, following a 12-week treatment

period. The GBSD was well accepted without any clinically significant troublesome effects. These results lead us to the conclusion that GBSD may have certain benefits as a complementary therapy for Stage 1 and 2 hypertensive patients.

Conflict of interest

All authors have no conflict of interest

Funding disclosure

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