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Review Article

Phytotherapy: A Systematic Review for the Treatment of Hypertension

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ABSTRACT

Introduction: Approximately 10 million annual deaths may be associated with hypertension. Adverse effects and non-response to pharmacological treatment limit therapy to a significant proportion of patients; hence, treatment alternatives seem necessary. Our objective was to review data about the impact of herbal medicine on reducing blood pressure (**BP**) in prehypertensive and hypertensive patients.

Methods: A systematic review was conducted (PRISMA guidelines), using PUBMED, SCOPUS, and WEB OF SCIENCE databases, without time restriction. The inclusion criteria were randomised controlled trials and quasi-experimental studies in humans focusing antihypertensive effect of phytotherapeutics: *Allium sativum*, *Apium graveolens*, *Nigella sativa*, *Panax ginseng*, and *Hibiscus sabdariffa* on BP in adults with prehypertension or hypertension. The exclusion criteria were the usage of combined medicinal plants. Data about systolic and diastolic BP differences before and after phytotherapy were extracted manually and summarised. The risk of bias was assessed using the JBI tool.

Results: Forty-five studies were selected (15 *A sativum*, 4 *A graveolens*, 4 *N sativa*, 9 *P ginseng*, and 13 *H sabdariffa)*. Antihypertensive effect was observed for *A sativum* systolic and diastolic BP (−18.1/−9 mmHg), *A graveolens* (−37.9/−15.4 mmHg), *N sativa* (−11.8/−8.8 mmHg), *P ginseng* (−17.4/−7.1 mmHg), and *H sabdariffa* (−61.4/−66.2 mmHg).

Discussion/Conclusions: Herbal medicines can reduce high BP levels in prehypertension and hypertension, when used alone or together with lifestyle changes or antihypertensive drugs. Results interpretation is crucial, given the studies quality variation and the discrepancies. More consistent clinical studies in humans are needed to accurately determine efficacy and safety in the treatment of hypertension.

Introduction

Arterial hypertension is classified as systolic blood pressure (**SBP**) > 140 mmHg (millimetre of mercury) or diastolic blood pressure (**DBP**) > 90 mmHg (Chobanian et al., 2003). Prehypertension is a designation used to identify people at high risk of developing hypertension, being classified when SBP is between 120 and 139 mmHg or a DBP between 85 and 89 mmHg (Chobanian et al., 2003). In addition to these, there is a subtype of hypertension known as white-coat hypertension, which refers to the elevation of blood pressure (**BP**) observed during medical consultations, while values remain normal outside this environment in people who are not under antihypertensive treatment (Kario et al., 2019). According to the American College of Cardiology and the American Heart Association, this condition is characterised by an office BP between 130/80 and 160/100 mmHg, while daytime BP is measured by ambulatory blood pressure monitoring (**ABPM**) or home BP measurement should be lower than 130/80 mmHg (Whelton et al., 2018).

The global prevalence of hypertension is 1.3 billion adults between the ages of 30 and 79, and approximately 10 million deaths a year may be associated with the hypertensive condition (World Health Organization, 2023; Zhou et al., 2021). Almost half of adults are unaware that they suffer from this chronic disease, and only 21% of adults with hypertension manage to control their condition (Global Health Observatory [GHO], 2023). If appropriate interventions are implemented to increase the rate of hypertension control to 50% worldwide, it is estimated that around 76 million deaths could be avoided between 2023 and 2050 (World Health Organization, 2023). Therefore, successful control of BP in patients with hypertension reduces the occurrence of all causes of cardiovascular mortality, including sudden death, stroke, coronary heart disease, heart failure, atrial fibrillation, arterial disease, and kidney dysfunction (Liu et al., 2024; Mensah et al., 2023).

The medications initially prescribed to control high BP are diuretics, long-acting calcium channel blockers, angiotensin-converting enzyme

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inhibitors, angiotensin II receptor blockers, and beta blockers (Joint Committee for Guideline Revision, 2019). A significant percentage (~70%) of hypertensive patients require more than two medications to reach recommended BP levels, thus increasing the risk of side effects and costs associated with treatment (Guerrero-García and Rubio-Guerra, 2018); and a significant percentage of patients with hypertension (14.7%) (Noubiap et al., 2019) do not respond to conventional treatment (Winner et al., 2024). Therefore, it is important to explore other treatment alternatives (Champaneria et al., 2023).

Phytotherapy is an area of medicine that uses plants to treat diseases or as health-promoting agents (Falzon and Balabanova, 2017). Studies indicate that some plants have antihypertensive properties, species such as garlic (*Allium sativum*), celery (*Apium graveolens*), black cumin (*Nigella sativa*), ginseng (*Panax ginseng*), and hibiscus (*Hibiscus sabdariffa*) and are among the most common and used therapeutically to control hypertension (Ajebli and Eddouks, 2020; Jänicke et al., 2003; Verma et al., 2021).

The objective of this systematic review was to gather and synthesise data from experimental trials that explored the most commonly used phytotherapeutic interventions in the treatment of hypertension (*A sativum*, *A graveolens*, *N sativa*, *P ginseng*, and *H sabdariffa*), in order to analyse their impact on BP in prehypertensive and hypertensive adults.

Methods

This systematic review was carried out following the PRISMA guidelines (Page et al., 2021), to answer the following research question prepared according to the PICO criteria (Huang et al., 2006) (Fig. 1): What is the impact of herbal medicine on reducing BP in prehypertensive and hypertensive patients compared to other therapies or no treatment?

All intervention studies in humans with prehypertension or hypertension, undergoing phytotherapy with *A sativum*, *A graveolens*, *N sativa*, Panax, and *H sabdariffa*, with any dosage or pharmaceutical form, were eligible for this systematic review. These herbal medicines were selected based on articles that brought together those most frequently used in the treatment of hypertension (Ajebli and Eddouks, 2020; Jänicke et al., 2003; Verma et al., 2021). Studies with normotensive participants were not included, as a BP-reducing effect was not observed in this population (Han et al., 1998; Mahdavi-Roshan et al., 2016; Nakasone et al., 2013; Ried et al., 2010).

The protocol for this systematic review was not formally registered. The non-registration of the protocol was based on factors restricted timeframe for carrying out the study and the exploratory focus of the research. We believe that, despite the absence of a formal register, the methodology employed guarantees the transparency and reproducibility of the process.

Search Strategy

The bibliographical research was carried out through the following electronic databases, PUBMED, SCOPUS, and WEB OF SCIENCE, using the search terms: "Hypertension AND Apium," "Hypertension AND Garlic," "Hypertension AND Hibiscus," "Hypertension AND Nigella," "Hypertension AND Panax," during the period from November 2022 to September 2024, there was no time limit for the inclusion of articles. The selection of studies was carried out by two researchers (author one and author two), and a third researcher (author three) checked and confirmed the information extracted from the articles. Information about the studies was extracted into a database in Microsoft Excel software (2019), where duplicate studies were removed, the titles and abstracts were individually examined, according to the defined eligibility criteria, and all articles that did not fit these were excluded.

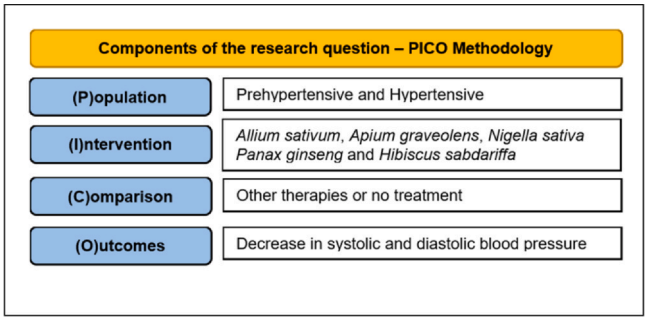

Fig. 1. Component of the research question—PICO Methodology.

Study Selection

Participants

Experimental studies in prehypertensive and/or hypertensive humans that evaluated the effect of herbal medicines on BP were considered. The minimum age parameter established was 18 years, and no maximum limits were intentionally set. In addition, no gender or ethnicity criteria were imposed.

Intervention

The five medicinal plants studied were garlic (*A sativum*), celery (*A graveolens*), black cumin (*N sativa*), ginseng (*P ginseng*), and hibiscus (*H sabdariffa*), regardless of dosage, pharmaceutical form, and administration time, with or without conventional medicines, administered alone or together with one of the other herbal medicines included. We excluded experimental studies on animals, *in vivo*, and *in vitro*, studies in which the intervention or interventions studied were accompanied by other medicinal plant(s) not studied in this review.

Control Group

The interventions were compared to control groups undergoing therapy with antihypertensive drugs, with different or the same herbal medicines, but with different doses, diet, and healthy lifestyle, or a combination of these therapies, with or without placebo.

Result Measurement

We included studies in which the impact of the intervention on systolic and/or DBP was measured.

Extraction of Results

The following data were extracted: bibliographic reference of the article, country in which the study was carried out, study design, sample characterisation (degree of hypertension, settings, size, distributed by sex and intervention, and control groups), type of intervention and control, with respective doses and pharmaceutical forms, duration of treatment and wash-out time, average BP values before and after treatment and between groups, when applied. Finally, when existing, reported adverse effects and antihypertensive medication.

Quality Assessment

The systematic quality of the included studies was assessed using the revised Joanna Briggs Institute critical appraisal tool for assessing the risk of bias (Aromataris and Munn, 2020).

Results

Study Selection

A total of 3 088 studies were identified, of which 1 193 duplicates were removed, and 1 895 articles were manually screened by the authors. A total of 1 808 articles were excluded for reasons of not meeting the eligibility criteria. In total, 87 studies were read in full, and of these,

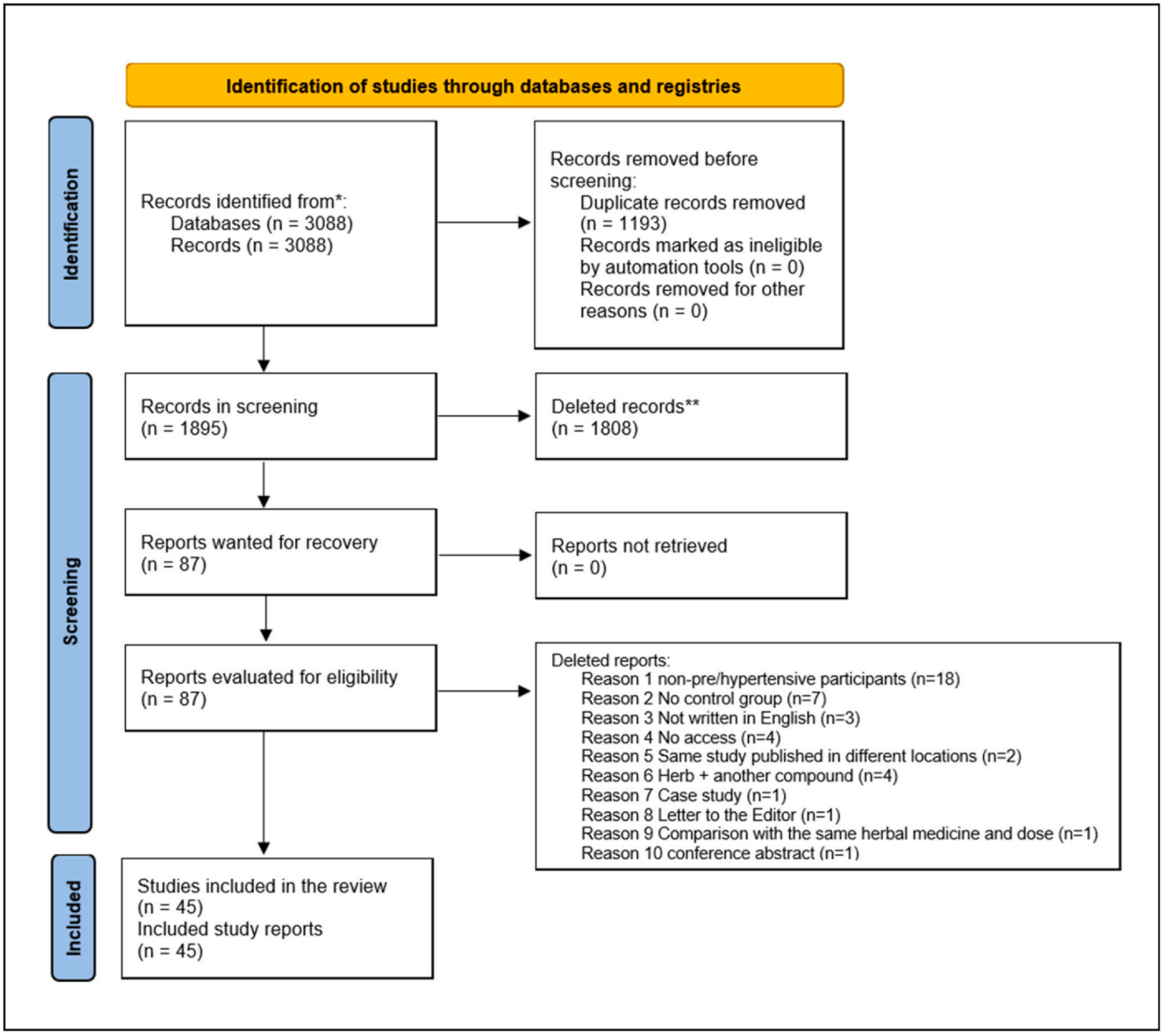

Fig. 2. PRISMA 2020 diagram, study selection.

42 trials were excluded overall (n = 18) because the sample was not prehypertensive or hypertensive. Finally, 45 articles were included in this review. The study selection process can be better seen in Figure 2.

Characteristics of the Studies

Garlic (Allium sativum)

Of the 45 articles, 15 evaluated the effect of the herbal medicine *A sativum* (Table 1), published from 2005 to 2024, carried out in several countries: Australia (Ried et al., 2010, 2013, 2016, 2018), India (Dhawan and Jain, 2005; Sindhu et al., 2022), Iran (Bahrani et al., 2020; Rahmatinia et al., 2024), Pakistan (Ashraf et al., 2013), Malaysia (Linoby et al., 2021), Japan (Nakasone et al., 2013), Spain (Serrano et al., 2023), and Brazil (Vila-Nova et al., 2024). The majority (n = 12) were randomised controlled trials (**RCTs**), of which one triple blind (Serrano et al., 2023), nine were double blind (Dhawan and Jain, 2005; Nakasone et al., 2013; Rahmatinia et al., 2024; Ried et al., 2010, 2013, 2016, 2018; Sobenin et al., 2009; Vila-Nova et al., 2024) and two were single-blind (Linoby et al., 2021; Mousa and Mousa, 2007), another three quasi-experimental (**QE**), being triple blind (Bahrani et al., 2020), simple blind (Ashraf et al., 2013), and not blind (Sindhu et al., 2022). The final analysis represented a total of 1 026 participants, ranging from 6 to 192 participants, the average age of those studied was between 25 and 71 years old. Just one article (Sobenin et al., 2009) included only male participants, the remainder of both sexes. Twelve studies included a participant population categorised as hypertensive (Ashraf et al., 2013; Bahrani et al., 2020; Dhawan and Jain, 2005; Mousa and Mousa, 2007; Ried et al., 2010, 2013, 2016, 2018; Serrano et al., 2023; Sindhu et al., 2022; Sobenin et al., 2009; Vila-Nova et al., 2024), two studies evaluated prehypertensive patients (Linoby et al., 2021; Rahmatinia et al., 2024), and another, both populations (Nakasone et al., 2013).

The dosages and dosage forms used in the interventions varied considerably from 240 to 4 000 mg daily in capsules, 250–2 500 mg daily in tablets, 250 mg in garlic pearls, and 20 000 mg daily in nature, with the total intake after treatment being 20–201.6, 21–252, 14, and 840 g, respectively. One study did not clearly identify the dosage and duration of intervention (Sindhu et al., 2022). Among the RCTs, 10 compared interventions to placebos and two to other treatments. In the case of QE, one compared it to a placebo and antihypertensive

Table 1
Allium sativum result synthesis.

Reference	Country	study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost – Igpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Ried et al., 2010)	Australia	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP ≥ 140 or DBP ≥ 90 mmHg)	General practices, home intervention	n = 50 IG: 25 (68%) CG: 25 (68%)	IG: x̄ 66 years CG: x̄ 66 years	Aged *Allium sativum* 960 mg Capsule	Placebo	12 Weeks	-	SBP		135.4 ± 14.1	136.2 ± 13.8	0.8	-6.6 ± 3.3		Burping, reflux and taste sensations (24%)	Digital sphygmomanometer / Stable antihypertensive treatment
											DBP		74.0 ± 10.3	75.5 ± 13.6	1.5	+2.5 ± 3.3			
(Ried et al., 2013)	Australia	RCT D. Blind Parallel	♂♀Systolic hypertension (SBP ≥ 140 mmHg)	General practices, home intervention	n = 74 (Not clear) IG1: 18 IG2: 20 IG3: 19 CG: 17	IG1: x̄ 70 years IG2: x̄ 67 years IG3: x̄ 70 years CG: x̄ 71years	Aged *Allium sativum* (S-allylcysteine) IG1: 240 mg (0.6 mg) IG2: 480 mg (1.2 mg) IG3: 960 mg (2.4 mg) Capsule	Placebo	12 Weeks	-	SBP	IG1	148.7 ± 2.8	138.8 ± 3.1	-9.8	IG1 vs CG	No significant differences between groups	Constipation, abdominal distension, flatulence, reflux, dry mouth, cough (32%)	Digital sphygmomanometer / Stable antihypertensive treatment
												IG2	149.3 ± 2.6	126.8 ± 2.8	-22.5	IG2 vs CG	**Different****		
												IG3	149.4 ± 2.7	132.4 ± 3.0	-17.1	IG3 vs CG	No significant differences between groups		
											DBP	IG1	76.9 ± 2.9	70.0 ± 3.1	-6.9	IG1 vs CG	Not reported		
												IG2	75.6 ± 2.8	66.6 ± 2.8	-9	IG2 vs CG	Not reported		
												IG3	75.9 ± 2.8	69.5 ± 3.0	-6.4	IG3 vs CG	Not reported		
(Mousa and Mousa, 2007)	Not clear	RCT S. Blind crossover	♂♀Hypertensive patients (SBP between 140–159 mmHg DBP 90–99 mmHg)	Not clear	n = 6 (Not reported)	Between 25-65 years	*Allium sativum* IG: 2500 mg *Allium sativum* Pill	Placebo	10 days	1 week	SBP		**Not clear****		**Not clear****	Not reported		Not reported	Not clear / Not reported
											DBP		Not clear		Not clear	Not reported			
(Nakasone et al., 2013)	Japan	RCT D. Blind Parallel	♂♀Pre-hypertensives (SBP between 130-139 mmHg or DBP 85-89 mmHg) and hypertensives (SBP between 140-159 mmHg or DBP 90-99 mmHg)	Hospital and home setting	n = 72(Not clear) IG1 Pre-H: 15 IG2 H: 19 CG1 Pre-H: 17 CG2 H:21	Not clear	*Allium sativum* 300 mg Capsule	Placebo	12 Weeks	-	SBP	Pre-Hypertensives	133.5 ± 1.2	129.9 ± 2.1	-3.6	No significant differences between groups		Gastric discomfort (38%), headaches (18%), abdominal pain with diarrhoea (12%)	Digital sphygmomanometer / No antihypertensive treatment
												Hypertensive	142.7 ± 1.3	136.1 ± 1.8	**-6.6****	**-0.7 ± 1.4***			
											DBP	Pre-Hypertensives	82.6 ± 1.7	80.9 ± 1.6	-1.7	No significant differences between groups			
												Hypertensive	90.2 ± 1.6	85.6 ± 1.5	**-4.6****	**-0.5 ± 1.0***			

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Table 1 (*continued*)

Reference	Country	study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost – Igpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Sindhu et al., 2022)	India	QE Not Blind Parallel	♂♀Hypertensive patients (SBP and DBP ≥140/90 mmHg)	Not clear	n = 60 IG: 30 (16.7%) CG 30 (40%)	Not clear	*Allium sativum* (Not clear)	Not clear	Not clear	-	SBP		131.67 ± 12.62	119.67 ± 11.89	**-12*****	Not reported		Not reported	Not reported / Not reported
											DBP		86.33 ± 9.28	80.33 ± 9.28	**-6****	Not reported			
(Ashraf et al., 2013)	**Pakistan**	QE S. Blind Parallel	♂♀Hypertensive patients (SBP between 140-159 mmHg and DBP 90-99 mmHg)	Primary health care centres, home intervention	n = 192 (Not clear) IG (1-5): 135 CG 6:30 CG 7:27	Not clear	*Allium sativum* IG1: 300 mg IG2: 600 mg, IG3: 900 mg IG4: 1200 mg IG5: 1500 mg Pill	CG 6: Atenolol 100 mg CG 7: Placebo	24 Weeks	-	**SBP**	**IG1**	**145.0 ± 0.70**	**142.7 ± 0.64**	-2.3*	**IG1 vs CG7**	Different**	Heartburn (1%)	Mercury sphygmomanometer / No antihypertensive treatment
												IG2	145.3 ± 0.79	141.0 ± 0.57	**-4.3****	IG2 vs CG7	**Different****		
												IG3	145.0 ± 0.80	138.9 ± 0.56	**-6.1****	IG3 vs CG7	**Different****		
												IG4	143.9 ± 0.81	137.2 ± 0.86	**-6.7****	IG4 vs CG7	**Different****		
												IG5	145.2 ± 0.67	137.6 ± 0.58	**-7.6****	IG5 vs CG7	**Different****		
												-	-	-	-	IG1-5 vs CG6	No significant differences between groups		
											DBP	IG1	93.15 ± 0.54	91.70 ± 0.51	-1.4	IG1 vs CG7	**Different****		
												IG2	93.11 ± 0.52	89.74 ± 0.37	**-3.4****	IG2 vs CG7	**Different****		
												IG3	92.79 ± 0.51	88.63 ± 0.51	**-4.2****	IG3 vs CG7	**Different****		
												IG4	92.97 ± 0.49	86.70 ± 0.59	**-6.2****	IG4 vs CG7	**Different****		
												IG5	91.93 ± 0.44	86.96 ± 0.45	**-5****	IG5 vs CG7	**Different****		
												-	-	-	-	IG1-5 vs CG6	No significant differences between groups		
(Dhawan and Jain, 2005)	India	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP and DBP > 140/90 mmHg)	Hypertension Clinic, home intervention	n = 40(Not clear) IG: 20 CG: 20	IG: x̄ 55 years CG: x̄ 47years	*Allium sativum* 250 mg Pearls	Healthy adults	8 Weeks	-	SBP		148 ± 12	140 ± 16	**-8***	No significant differences between groups		Mild gastrointestinal discomfort and increased intestinal motility (15%)	Not clear / No antihypertensive treatment
											DBP		94 ± 15	85 ± 23	**-9***	No significant differences between groups			
(Linoby et al., 2021)	Malaysia	RCT S. Blind crossover	♂♀Pre-Hypertensives (SBP between 120-139 mmHg or DBP 80-89 mm Hg)	Not clear	n = 18(61%)	Not reported	*Allium sativum* enriched with Polysulfide 4000 mg Capsule	Placebo	5 days	10 days	SBP		129 ± 4	126 ± 5	**-3****	**Different****		Not found	Digital sphygmomanometer / Not reported
											DBP		Not clear	Not clear	No differences	No significant differences between groups			

(*continued on next page*)

Table 1 (*continued*)

Reference	Country	study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results				Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost – Igpre (mmHg)	Mean ± SD		
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)		
(Bahrani et al., 2020)	Iran	QE T. Blind Parallel	♂♀Hypertensive patients (SBP and DBP > 140/90 mmHg)	Hospital setting, home intervention	n = 101 IG1: 33(42%) IG2:33 (42%) CG: 35(46)	IG1: x̄ 56 years IG2: x̄ 56 years CG: x̄ 54 years	*Allium sativum* (IG1) 20000 mg Raw	No treatment	6 Weeks	1 week	SBP DBP	IG1 IG1	153.78 ± 9.43 97.27 ± 6.74	138.33 ± 10.94 90.30 ± 6.72	**-15.5***** **-7*****	No significant differences between groups **Different***	Not reported	Not reported / Stable antihypertensive treatment
(Ried et al., 2016)	Australia	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP ≥140 mmHg and/or DBP ≥90 mmHg)	Clinic, home intervention	n = 88 IG: 50 (56%) CG: 38 (50%)	IG: x̄ 63 years CG: x̄ 61 years	Aged *Allium sativum* 2400 mg Capsule	Placebo	12 Weeks	-	SBP DBP		148.7 ± 15.3 89.9 ± 11.7	141.7 ± 15.3 86.1 ± 11.3	-7 -3.8	**-5 ± 2.1*** -1.9 ± 1.2	Reflux (8%), burping (5%), bloating (3%)	Digital sphygmomanometer / Stable antihypertensive treatment
(Ried et al., 2018)	Australia	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP ≥140 mmHg and/or DBP ≥90 mmHg)	Clinic, home intervention	n = 49 IG: 23 (44%) CG: 26 (46%)	IG: x̄ 63 years CG: x̄ 62 years	Aged *Allium sativum* 2400 mg Capsule	Placebo	12 Weeks	-	SBP DBP		153.3 ± 16.4 93 ± 10.9	139 ± 15.1 83.1 ± 10.4	-14.3 -9.9	**-10 ± 3.6**** **-5.4 ± 2.3***	Not found	Digital sphygmomanometer / Stable antihypertensive treatment and no antihypertensive treatment

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Table 1 (*continued*)

Reference	Country	study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost – Igpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Sobenin et al., 2009)	Not clear	RCT D. Blind Parallel	♂Hypertensive patients (SBP between 150-160 mmHg and DBP 90-115 mmHg)	Not clear	n = 84 IG1: 30 IG2: 18 CG3: 16 CG4: 20	IG1: x̄ 51 years IG2: x̄ 51 years CG3: x̄ 52years CG4: x̄ 53years	Long-acting *Allium sativum* IG1: 600 mg IG2: 2400 mg Pills	CG3: Regular-acting *Allium sativum* 900 mg CG4: Placebo	8 Weeks	-	SBP	IG1	Not clear	Not clear	**-7*****	IG1 vs CG4 IG2 vs CG4	**Different***** **Different*****	Not found	Not reported / Not clear
												IG2	Not clear	Not clear	**-9.3*****	IG2 vs IG1 CG3 vs IG1 or IG2	No significant differences between groups No significant differences between groups		
											DBP	IG1	Not clear	Not clea	**-3.8*****	IG1 vs CG4 IG2 vs CG4	**Different***** **Different*****		
												IG2	Not clear	Not clear	**-3.2*****	IG2 vs IG1 CG3 vs IG1 or IG2	No significant differences between groups No significant differences between groups		
(Serrano et al., 2023)	Spain	RCT T. Blind Parallel	♂♀Hypertensive patients (SBP ≥140 mmHg and/or DBP ≥90 mmHg)	Hospital and home setting	n = 77 IG: 39 -51% CG: 38 -52%	IG: x̄ 63 years CG: x̄ 64 years	Aged black *Allium sativum* 250 mg Tablet	Placebo	12 Weeks	-	SBP		146 ± 21	143 ± 18	-3	No significant differences between groups		Mild gastric discomfort and muscle cramps (8%)	Digital sphygmomanometer / Stable antihypertensive treatment
											DBP		85 ± 10	83 ± 9	-2	No significant differences between groups			

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Table 1 (*continued*)

Reference	Country	study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Washout	Parameters	Results				Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
												Mean ± SD		IGpost – Igpre (mmHg)	Mean ± SD		
												IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)		
(Vila-Nova et al., 2024)	Brazil	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP ≥140 mmHg and/or DBP ≥90 mmHg)	University's Department of Nutrition, home intervention	n= 19 IG: 9 -67% CG: 10 -60%	IG: x̄ 39 years CG: x̄ 47 years	Aged *Allium sativum* (S-allylcysteine) 1200 mg Tablet	Placebo	12 Weeks	-	SBP	Not reported	Not reported	**-18.1***	No significant differences between groups	Not found	Manual sphygmomanometers / Stable antihypertensive treatment
											DBP	Not reported	Not reported	-5.6	No significant differences between groups		
(Rahmatinia et al., 2024)	Iran	RCT D. Blind Parallel	♂♀Pre-Hypertensives (SBP between 120-139 mmHg or DBP 85-89 mm Hg)	Health care centres, home intervention	n= 96 IG: 47 -47% CG:49 -53%	IG: x̄ 50 years CG: x̄ 50 years	*Allium sativum* 450 mg Capsule	Placebo	8 Weeks	-	SBP	127.85 ± 6.87	124.95 ± 5.65	-2.9***	Different*	Not reported	Digital sphygmomanometer / No antihypertensive treatment
											DBP	83.36 ± 9.94	80.08 ± 8.49	**-3.28*****	**Different***		

D., double; DBP, diastolic blood pressure; IG, intervention group; mmHg, millimetre of mercury; QE, quasi-experimental; RCTs, randomized controlled trials; S., simple; SBP, systolic blood pressure; SD, standard deviation; T., triple.

Age and results expressed as average.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$ represents significant difference.

medication, another to a control group without treatment, and one study did not make the comparison group clear.

The studies were carried out in a variety of health care settings, ranging from primary care practices to hospital and home environments. Of the studies analysed, two were conducted in general practices (Ried et al., 2013, 2010), two combined hospital and home assessments (with home intervention) (Nakasone et al., 2013; Serrano et al., 2023), and others were distributed between primary care centres (Ashraf et al., 2013; Rahmatinia et al., 2024), hypertension clinics (Dhawan and Jain, 2005), various clinics (Ried et al., 2018, 2016), hospital (Bahrani et al., 2020), and a university nutrition department (Vila-Nova et al., 2024). For the most part, the assessments and monitoring were carried out in these locations, while the phytotherapy was administered at home by the participants.

Celery (Apium graveolens)

Four studies on Celery were included in this review (Table 2), published between 2022 and 2024, three carried out in (Mohsenpour et al., 2023; Shayani Rad et al., 2023, 2022) and one in Indonesia (Febriza et al., 2024). The majority (n = 3) were RCTs, of which two were triple blind (Shayani Rad et al., 2023, 2022), one double blind (Mohsenpour et al., 2023), and QE unblinded (Febriza et al., 2024). The final analysis represented a total of 211 participants, ranging from 36 to 74 participants, and the average age was between 50 and 56 years old. Three studies included a population categorised as hypertensive (Febriza et al., 2024; Shayani Rad et al., 2023, 2022), and one both pre- and hypertensive population (Mohsenpour et al., 2023). The information on settings was not clearly specified in any of the four studies analysed.

A wide variation was observed in the doses and forms of administration used in the interventions, with dosages of 750–1 340 mg in capsule from and 150–250 ml daily in decoction (100.000 mg of leaf). Doses of 37–63 g, 4–7 l were administered in capsule and decoction form, respectively.

All the RCTs compared the interventions with placebos and in the QE study, the intervention was compared with antihypertensive drugs.

Black Cumin (Nigella sativa)

We included four citations that studied *N sativa* (Table 3), published between 2008 and 2021, carried out in Iran (Dehkordi and Kamkhah, 2008; Nooshirvani et al., 2018; Shoaei-Hagh et al., 2021) and in Indonesia (Rizka et al., 2017). In terms of study design, three were RCTs (Dehkordi and Kamkhah, 2008; Rizka et al., 2017; Shoaei-Hagh et al., 2021) and one was a QE (Nooshirvani et al., 2018), all with a double-blind method. The final analysis represented a total of 282 participants, samples ranging from 50 to 108, and the average age was between 43 and 74 years old. An investigation (Dehkordi and Kamkhah, 2008) included only male participants, the remainder of both sexes. Three articles studied a sample categorised as hypertensive (Dehkordi and Kamkhah, 2008; Rizka et al., 2017; Shoaei-Hagh et al., 2021). Investigations, in which hypertension was concomitant with another pathology, as was the case with diabetes mellitus 2 (**DM2**) (Nooshirvani et al., 2018), were also selected. With regard to the setting, three studies were carried out in a hospital environment (Dehkordi and Kamkhah, 2008; Nooshirvani et al., 2018; Rizka et al., 2017) and one in a cardiology centre (Shoaei-Hagh et al., 2021). In all cases, the interventions were carried out at home by the participants.

Regarding the dosages and dosage forms used in the interventions, there were variations from 100 to 600 mg daily in capsules, with the total intake after treatment being 5.6–22.4 g. One study analysed administration in oil with a dosage of 5 ml for 8 weeks. All intervention groups from the four included studies were compared to a placebo group.

Panax ginseng

A total of nine studies included citations about the herbal medicine *P ginseng* (Table 4), published between 1998 and 2021, carried out in the following countries: Croatia (Jovanovski et al., 2021), South Korea (Han et al., 1998), Canada (Stavro et al., 2005, 2006), and one multicentre in Croatia and Canada (Jovanovski et al., 2020). We also refer to studies in which the location was not clear (Cha et al., 2016; Mucalo et al., 2013; Rhee et al., 2014, 2011). All included studies had a randomised controlled research design, of which six were double blind (Cha et al., 2016; Mucalo et al., 2013; Rhee et al., 2011, 2014; Stavro et al., 2005, 2006) and three single blinding (Han et al., 1998; Jovanovski et al., 2020, 2021), with samples ranging from 16 to 80 participants, with the final analysis carried out on 517 participants of both sexes, aged between 41 and 64 years.

Four studies aimed to evaluate hypertensive patients, one study focused only on prehypertensive individuals (Cha et al., 2016), and another evaluated both populations (Rhee et al., 2014). Three studies included participants with DM2 and concomitant hypertension (Jovanovski et al., 2021, 2020; Mucalo et al., 2013). The studies were conducted in different settings: a diabetes outpatient clinic (Mucalo et al., 2013), two university medical centres (Han et al., 1998; Jovanovski et al., 2021), and three hospitals (Jovanovski et al., 2020; Stavro et al., 2006, 2005). In all the studies, the interventions were carried out at home by the participants.

The dosages analysed in the intervention groups ranged from 100 to 5 000 mg daily in capsules, with the total intake after treatment being 5.6–420 g. All intervention groups from the nine included studies were compared to a placebo group.

Hibiscus (Hibiscus sabdariffa)

Thirteen articles were included that were dedicated to investigating the medicinal plant *H sabdariffa* (Table 5). Published between 1999 and 2024, four surveys carried out in Iran (Dehkhoda et al., 2024; Haji Faraji and Haji Tarkhani, 1999; Jalalyazdi et al., 2019; Mozaffari-Khosravi et al., 2013), two in Nigeria (Nwachukwu et al., 2015, 2017), two in Senegal (Bourqui et al., 2021; Seck et al., 2017), two studies conducted in Indonesia (Kundarti et al., 2024; Yusni and Meutia, 2020), Mexico (Herrera-Arellano et al., 2007), USA (McKay et al., 2010), and Iraq (Al-Anbaki et al., 2021).

The majority (n = 10) were RCTs, of which four were double blind (Dehkhoda et al., 2024; Herrera-Arellano et al., 2007; McKay et al., 2010; Nwachukwu et al., 2017), four single blinds (Haji Faraji and Haji Tarkhani, 1999; Mozaffari-Khosravi et al., 2013; Nwachukwu et al., 2015; Seck et al., 2017), and two open (Bourqui et al., 2021; Jalalyazdi et al., 2019), other three non-blind QE (Al-Shafei and El-Gendy, 2013; Kundarti et al., 2024; Yusni and Meutia, 2020). The final analysis represented a total of 1 219 participants, ranging from 16 to 218 participants, the average age was between 25 and 68 years old. Two article included only female participants (Kundarti et al., 2024; Yusni and Meutia, 2020), the remainder, both sexes. Nine studies included a population categorised as hypertensive (Al-Anbaki et al., 2021; Bourqui et al., 2021; Dehkhoda et al., 2024; Haji Faraji and Haji Tarkhani, 1999; Herrera-Arellano et al., 2007; Kundarti et al., 2024; Nwachukwu et al., 2015, 2017; Seck et al., 2017), a prehypertensive study (Jalalyazdi et al., 2019), and another, both populations (McKay et al., 2010). Participants categorised with Metabolic Syndrome (Yusni and Meutia, 2020) and DM2 (Mozaffari-Khosravi et al., 2013), with pre- or concomitant hypertension, were also selected. The studies were carried out in various settings: a nursing home for the elderly (Yusni and Meutia, 2020), five hospitals (Haji Faraji and Haji Tarkhani, 1999; Herrera-Arellano et al., 2007; Nwachukwu et al., 2015, 2017; Seck et al., 2017), a cardiology outpatient clinic (Jalalyazdi et al., 2019), a university medical centre (McKay et al., 2010), two health centres (Al-Anbaki et al., 2021; Kundarti et al., 2024), a community medical centre (Bourqui et al., 2021), and a research centre (Mozaffari-Khosravi et al., 2013). In one study, the intervention took place in a hospitalisation setting (hospitalisation medical centre) (Dehkhoda et al., 2024), and in one of the studies carried out in health centres (Kundarti et al., 2024), the place of intervention was not clearly specified. In all the other studies, the interventions were carried out at home by the participants.

A wide variation was observed in the doses and forms of

Table 2
Apium graveolens result synthesis.

Reference	Country	Study design	Participants	Settings	Sample % male)	Age	Dose of herbal medicine/ day and galenic form	Compar-ison	Duration	Wash-out	Parameters		Results				Adverse effects	Others (Measuring device/ Use of antihyper-tensive drugs)
													Mean ± SD		IGpost – IGpre (mmHg)	Mean ± SD		
													IGpre (mmHg)	IGpost (mmHg)		IGpost – CGpost (mmHg)		
(Shayani Rad et al., 2022)	Iran	RCT T. Blind Crossover	♂♀Hypertensive patients (SBP between 120 and 160 mmHg or DBP 80–100 mmHg)	Not clear	n = 51 IG: 25 (51.85%) CG: 26 (50%)	IG: x̄ 50 y CG: x̄ 51 y	*Apium graveolens* 1340 mg Capsule	Placebo	4 wk	4 wk	SBP		142.06 ± 5.11	130.78 ± 5.74	−11.08***	Different***	Stomach reflux (8%) Skin irritation (4%) Swelling (4%) Nausea (4%)	ABPM (24-h)/Stable antihyper-tensive treatment
											DBP		92.05 ± 5.52	85.53 ± 5.06	−6.54***	Different***		
(Shayani Rad et al., 2023)	Iran	RCT T. Blind Crossover	♂♀ Hypertensive patients (SBP between 120 and 160 mmHg or DBP 80–100 mmHg)	Not clear	n = 50 IG: 25 (48%) CG: 25 (48%)	IG: x̄ 51 y CG: x̄ 50 y	*A graveolens* 1340 mg Capsule	Placebo	4 wk	4 wk	SBP		141.68 ± 6.11	130.38 ± 5.23	−11.03***	Different***	Headache Skin irritation Swelling Abdominal pain (2%)	ABPM (24-h)/Stable antihyper-tensive treatment
											DBP		92.17 ± 5.35	84.82 ± 4.78	−7.35***	Different***		
(Mohsenpour et al., 2023)	Iran	RCT D. Blind Parallel	♂♀Prehypertensive and Hypertensive patients (SBP between 120 and 159 mmHg or DBP 80–99 mmHg)	Not clear	n = 36 IG: 18 (39%) CG: 18 (33%)	IG: x̄ 56 y CG: x̄ 56 y	*A graveolens* 750 mg Capsule	Placebo	12 wk	-	SBP		Not reported	Not reported	−5*	No significant differences between groups	Not found	Mercury sphygmo-manom-eter/Not reported
											DBP		Not reported	Not reported	−8**	No significant differences between groups		
(Febriza et al., 2024)	Indonesia	QE Not Blind Parallel	♂♀ Hypertensive patients (Not reported)	Not clear	n = 74 (24%) IG1: 24 IG2: 22 CG: 28	IG1, IG2 e CG: x̄ 51 y	*A graveolens* (leaf 100 000 mg) IG1: 150 ml IG2: 250 ml Decoction	Antihyp-erten-sives	4 wk	-	SBP	IG1	155.00 ± 18.41	135.83 ± 21.45	−19.17**	Not reported	Not reported	Sphygmo-manom-eter/Not clear
												IG2	147.00 ± 11.08	109.09 ± 18.79	−37.91**	Not reported		
											DBP	IG1	90.83 ± 7.75	82.92 ± 13.9	−7.91**	Not reported		
												IG2	89.09 ± 6.83	73.64 ± 10.02	−15.45**	Not reported		

ABPM, ambulatory blood pressure monitoring; CG, control group; D., double, DBP, diastolic blood pressure; IG, intervention group; mmHg, millimetre of mercury; QE, quasi-experimental; RCTs, randomised controlled trials; SBP, systolic blood pressure; SD, standard deviation; T., triple.
Age and results expressed as average.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$ represents significant difference.

Table 3
Nigella sativa result synthesis.

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device/ Use of antihypertensive drugs)
													Mean ± SD		IGpost – IGpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	**IGpost (mmHg)**		**IGpost – Cgpost (mmHg)**			
(Shoaei-Hagh et al., 2021)	Iran	RCT D. Blind Parallel	♂♀Hypertensive (SBP ≥140 mmHg or DBP ≥90 mmHg)	Cardiology centre, home intervention	n = 55 IG: 26 (42%) CG: 29 (31%)	IG: x̄ 58 y CG: x̄ 60 y	*Nigella sativa* 5 ml Oil	Placebo	8 wk	-	SBP		142.5-0 ± 10-.33	134.1-3 ± 12-.03	−8.37***	Different*		Not found	Manual sphygmomanometers/ Stable antihypertensive treatment
											DBP		87.47 ± 7.15	78.93 ± 8.15	−8.54***	Different***			
(Dehkordi and Kamkhah, 2008)	Iran	RCT D. Blind Parallel	♂Hypertensive patients (SBP between 140 and 159 mmHg and/or DBP 90–99 mmHg)	Hospital setting, home intervention	n = 108 IG1: 36 IG2: 39 CG: 33	IG1: x̄ 45 y IG2: x̄ 44 y CG: x̄ 43 y	*N sativa* IG1: 200 mg IG2: 400 mg Capsule	Placebo	8 wk	-	SBP	IG1	Not clear	Not clear	Not clear*	IG1 vs CG	Different**	Not found	Digital sphygmomanometers/No antihypertensive treatment
												IG2	Not clear	Not clear	Not clear**	IG2 vs CG	Different**		
											DBP	IG1	Not clear	Not clear	Not clear**	IG1 vs CG	Different**		
												IG2	Not clear	Not clear	Not clear**	IG2 vs CG	Different**		
(Rizka et al., 2017)	Indonesia	RCT D. Blind Parallel	♂♀Hypertensive patients > 60 y old (SBP > 140 mmHg and/or DBP > 90 mmHg)	Hospital setting, home intervention	n = 69 (Not clear) IG: 33 CG: 36	IG: x̄ 72 y CG: x̄ 74 y	*N sativa* 600 mg Capsule	Placebo	4 wk	-	SBP		160.4 ± 15.7	145.8 ± 19.8	−14.6	Not reported		Dyspepsia (32%) Nausea (16%) Constipation (10%)	Digital sphygmomanometers/ Stable antihypertensive treatment, up to three drugs
											DBP		78.3 ± 1.9	74.4 ± 8.2	−3.9	Not reported			
(Nooshirvani et al., 2018)	Iran	QE D. Blind Parallel	♂♀Type 2 diabetics with SBP and DBP > 140/ 90 mmHg	Hospital setting, home intervention	n = 50 IG: 25 (32%) CG: 25 (27%)	IG: x̄ 53 y CG: x̄ 53 y	*N sativa* 100 mg Capsule	Placebo	8 wk	-	SBP		144.1-1 ± 12-.14	130.1-7 ± 11-.81	−11.8***	Not reported		Not found	Not reported/ Stable antihypertensive treatment
											DBP		95.61 ± 9.14	82.13 ± 8.84	−8.8***	Not reported			

CG, control group; D., double; DBP, diastolic blood pressure; IG, intervention group; mmHg, millimetre of mercury; QE, quasi-experimental; RCTs, randomised controlled trials; SBP, systolic blood pressure; SD, standard deviation.
Age and results expressed as average.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$ represents significant difference.

Table 4
Synthesis of *Panax ginseng* results.

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Rhee et al., 2014)	Not clear	RCT D. Blind Parallel	♂♀Pre-hypertensive and Hypertensive patients (SBP between 120–159 mmHg or DBP 80–99 mmHg)	Not clear	n = 80 (Not clear) IG1: 26 IG2: 25 CG: 29	IG1: x̄ 56 years IG2: x̄ 57 years CG: x̄ 52 years	*Korean ginseng* IG1: 100 mg IG2: 300 mg Capsule	Placebo	8 Weeks	2 weeks	SBP	IG1	Not reported	Not reported	Not clear	IG1 and IG2 vs CG	No significant differences between groups	Dizziness, gastrointestinal discomfort and facial flushing (Not reported)	Digital sphygmomanometer / Stable antihypertensive treatment
												IG2	Not reported	Not reported	**-3.1***				
											DBP	IG1	Not reported	Not reported	Not clear	IG1 and IG2 vs CG	No significant differences between groups		
												IG2	Not reported	Not reported	**-2.3***				
(Cha et al., 2016)	Not clear	RCT D. Blind Parallel	♂♀Pre-hypertensive (SBP between 120-139 mmHg or DBP 80-89 mmHg)	Not clear	n = 62 IG: 31 (77.4%) CG: 31 (84%)	IG: x̄ 43 years CG: x̄ 41years	*Korean Red ginseng* 5000 mg Capsule	Placebo	12 Weeks	-	SBP		133.5 ± 2.37	127.0 ± 1.81	**-6.5****	Not clear		Not found	Digital sphygmomanometer / No antihypertensive treatment
											DBP		85.2 ± 1.20	80.2 ± 1.21	**-5****	**Different*****			
(Mucalo et al., 2013)	Not clear	RCT D. Blind Parallel	♂♀Hypertensive type 2 diabetics (SBP and DBP < 160/100 mmHg)	Diabetes outpatient clinic, home intervention	n = 64 IG: 30 (33.3%) CG: 34 (35.3%)	IG: x̄ 62 years CG: x̄ 64 years	*North American ginseng* 3000 mg Capsule	Placebo	12 Weeks	-	SBP		148.5 ± 9.65	131.1 ± 13.13	**-17.4*****	**Different*****		Not found	Digital sphygmomanometer / Stable antihypertensive treatment
											DBP		84.9 ± 9.19	77.8 ± 10.05	**-7.1****	No significant differences between groups			
(Jovanovski et al., 2021)	Croatia	RCT S. Blind Parallel	♂♀Type 2 diabetics (HbA1c: 6.5-8%) hypertensive (SBP 140-160 mmHg)	University medical centre, home intervention	n = 80 IG: 43 (62.8%) CG: 37 (59.4%)	IG: x̄ 59 years CG: x̄ 60 years	*Korean Red ginseng* (Enriched with Rg3) + North American ginseng 2250 mg Capsule	Placebo	12 Weeks	-	SBP		123.46 ± 1.6	121.76 ± 1.6	-1.7	**-3.98 ± 2.0***		Headache (7%) Nausea (2%) Abdominal discomfort -14%	ABPM (24-hour) / Stable antihypertensive treatment
											DBP		73.97 ± 1.1	73.33 ± 1.1	-0.65	-0.96 ± 1.6			
(Rhee et al., 2011)	Not clear	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP and DBP < 160/100 mmHg)	Not clear	n = 64 IG: 30 (46.7%) CG: 34 (41.2%)	IG: x̄ 55 years CG: x̄ 58 years	*Korean Red ginseng* 3000 mg Capsule	Placebo	12 Weeks	-	SBP		138 ± 13	134 ± 11	-4	No significant differences between groups		Flushing (5%) Gastrointestinal discomfort (9%) Itching (9%)	Digital sphygmomanometer / Stable antihypertensive treatment
											DBP		87 ± 10	83 ± 10	**-4***	No significant differences between groups			

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Table 4 (*continued*)

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD			
													IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Han et al., 1998)	South Korea	RCT S. Blind crossover	♂♀Hypertensive patients (SBP > 140 mmHg and DBP > 90 and < 110 mmHg)	University medical centre, home intervention	n = 34 (50%)	x̄ 59 years	*Korean Red ginseng* 4500 mg Capsule	Placebo (4 weeks)	8 Weeks	-	SBP	White coat hypertension (n = 8)	138.0 + 15.1	127.3 ± 11.3	-10.7	No significant differences between groups	Abdominal discomfort (6%) Diaphoresis (9%) Tiredness and drowsiness (12%) Constipation and dyspepsia (6%)	ABPM (24-hour) / Stable antihypertensive treatment and no antihypertensive treatment	
												Hypertensive (n = 26)	147.9 ± 14.2	143.6 ± 10.3	**-4.3***	**Different***			
											DBP	White coat hypertension (n = 8)	79.0 ± 6.1	74.7 ± 7.5	-4.3	No significant differences between groups			
												Hypertensive (n = 26)	91.6 ± 8.6	87.8 ± 5.7	-3.8	No significant differences between groups			
(Stavro et al., 2006)	Canada	RCT D. Blind Crossover	♂♀Hypertensive patients (SBP 140 mmHg or DBP 90 mm Hg)	Hospital setting, home intervention	n = 37 (81%)	x̄ 58 years	*North American ginseng* 3000mg Capsule	Placebo (4 weeks)	12 Weeks	8 Weeks	SBP		129.6 ± 1.8	130.9 ± 2.0	1.3	No significant differences between groups	Headache and diarrhoea (5%)	ABPM (24-hour) / Stable antihypertensive treatment	
											DBP		79.7 ± 1.3	80.6 ± 1.5	0.9	No significant differences between groups			

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Table 4 (*continued*)

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters	Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
												Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD			
												IGpre (mmHg)	IGpost (mmHg)		IGpost - CGpost (mmHg)			
(Stavro et al., 2005)	Canada	RCT D. Blind Crossover	♂♀Hypertensive patients (SBP 140 mmHg or DBP 90 mmHg)	Hospital setting, home intervention	n = 16 (75%)	$\bar{x}$ 61 years	*North American ginseng* IG 1-6: 3000 mg (6 different lots) Capsule	CG 7 and 8: Placebo	1 time a week	1 week (After each dose)	SBP	136.9 ± 2.2	Not reported	2.7	No significant differences between groups	Not found	Digital sphygmomanometer / Stable antihypertensive treatment (n = 13)	
											DBP	84.3 ± 1.7	Not reported	-1.4	No significant differences between groups			
(Jovanovski et al., 2020)	Croatia and Canada	RCT S. Blind Parallel	♂♀Type 2 diabetics (HbA1c ≤8.5%) hypertensive (SBP ≥140 mmHg or DBP ≥ 90 mmHg)	Hospital setting, home intervention	n = 80 (Not clear) IG: 43 CG: 37	IG: $\bar{x}$ 59 years CG: $\bar{x}$ 60 years	*North American ginseng* and *Korean Red ginseng* (Enriched with 75 mg of Rg3) 2250 mg Capsule	Placebo	12 Weeks	-	SBP	Not clear	Not clear	-3.38	**-4.69 ± 2.24***	Not found	Not clear / Stable antihypertensive treatment	
											DBP	78.70 ± 1.9	73.69 ± 2.0	**-5.1****	-2.99. ± 2.1			

ABPM, ambulatory blood pressure monitoring; CG, control group; D., double; DBP, diastolic blood pressure; IG, intervention group; mmHg, millimetre of mercury; RCTs, randomized controlled trials; S., simple; SBP, systolic blood pressure; SD, standard deviation.

Age and results expressed as average.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$ represents significant difference.

Table 5
Synthesis result *Hibiscus sabdariffa*.

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD IGpost - CGpost (mmHg)			
													IGpre (mmHg)	IGpost (mmHg)					
(Yusni and Meutia, 2020)	Indonesia	QE Not Blind Parallel	♀ > 60 years with metabolic syndrome (SBP and DBP > 140/90 mmHg)	Elderly nursing home	n = 16 IG: n = 8 CG: n = 8	IG: x̄ 68 years CG: x̄ 67years	*Hibiscus sabdariffa* 4000 mg Not clear	No treatment	3 weeks	-	SBP		162.50 ± 11.65	146.25 ± 7.90	**-16.25*****	**Different****		Not found	Mercury sphygmomanometer / Stable antihypertensive treatment
											DBP		88.75 ± 8.34	85.62 ± 6.78	**-3.13***	No significant differences between groups			
(Herrera-Arellano et al., 2007)	Mexico	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP and DBP > 140/90 mmHg)	Hospital setting, home intervention	n = 168 (Not reported) IG: It's not clear CG: It's not clear	Between 25-61 years	*Hibiscus sabdariffa* 250 mg Water soluble solution	CG: 10 mg Lisinopril	4 weeks	-	SBP		Not clear	Not clear	**-17.14*****	**Different***		Not found	Not reported / No antihypertensive treatment
											DBP		Not clear	Not clear	**-11.97*****	**Different***			
(Seck et al., 2017)	Senegal	RCT S. Blind Parallel	♂♀Hypertensive patients (SBP and DBP > 140/90 mmHg)	Hospital setting, home intervention	n = 125 IG1: 42 (38.1%) IG2: 42 (38.8%) CG: 41 (36.6%)	IG1: x̄ 53 years IG2: x̄ 55 years CG: x̄ 56 years	*Hibiscus sabdariffa* (IG1) 640 mg Capsule	CG: 5 mg Ramipril	4 weeks	-	SBP	IG1	155.4 ± 9.5	Not clear	**-11.2*****	**Different*****		Not found	Digital sphygmomanometer / No antihypertensive treatment
											DBP	IG1	95.4 ± 5.9	Not clear	**-6*****	No significant differences between groups			
(Nwachukwu et al., 2017)	Nigeria	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP between 130-179 mmHg and DBP 85-109 mmHg)	Hospital setting, home intervention	n = 75 (57.7%) IG: 25 CG1: 26 CG2: 24	IG: x̄ 50 years CG1: x̄ 49years CG2: x̄ 53years	*Hibiscus sabdariffa* 150 mg/kg weight Infusion	CG1: Placebo CG2: Lisinopril 10 mg	4 weeks	-	SBP		Not clear	Not clear	**-17*****	IG vs CG2 CG2 vs CG1 IG vs CG1	**Different***** **Different***** **Different*****	Not reported	Mercury sphygmomanometer / No antihypertensive treatment
											DBP		Not clear	Not clear	**-12.1*****	IG vs CG2 CG2 vs CG1 IG vs CG1	**Different***** **Different***** **Different*****		
(Nwachukwu et al., 2015)	Nigeria	RCT S. Blind Parallel	♂♀Hypertensive patients (SBP between 140-179 DBP 90-109 mmHg)	Hospital setting, home intervention	n = 75 (Not reported) IG1: 25 CG1: 25 CG2: 25	IG: x̄ 50 years CG1: x̄ 49years CG 2: x̄ 51 years	*Hibiscus sabdariffa* 150 mg/kg weight Infusion	CG1: Placebo CG2: Hydrochlorothiazide 25 mg	4 weeks	-	SBP		150.88 ± 7.33	133.80 ± 1.77	-17	IG vs CG1 CG2 vs CG1	**Different***** **Different***	Not found	Mercury sphygmomanometer / Not reported
											DBP		100.20 ± 5.96	88.08 ± 1.12	-12.1	IG vs CG1 CG2 vs CG1	**Different***** **Different*****		
(Jalalyazdi et al., 2019)	Iran	RCT Not Blind Parallel	♂♀Pre-hypertensive (SBP between 130-139 mmHg and DBP 80-89 mmHg)	Outpatient cardiology clinic, home intervention	n = 46 IG: 23 (48%) CG: 23 (52%)	IG: x̄ 50 years CG: x̄ 50 years	*Hibiscus sabdariffa* 1250 mg Infusion	No treatment	4 weeks	-	SBP		134.61 ± 2.67	127.17 ± 1.37	**-7.4*****	**Different*****		Not reported	Manual sphygmomanometer / Not reported
											DBP		84.87 ± 1.87	78.17 ± 2.01	**-6.7*****	**Different*****			

(*continued on next page*)

Table 5 (*continued*)

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters		Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
													Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD IGpost - CGpost (mmHg)			
													IGpre (mmHg)	IGpost (mmHg)					
(McKay et al., 2010)	USA	RCT D. Blind Parallel	♂♀Pre-hypertensive and Hypertensive patients (SBP between 120-150 mmHg and DBP ≤95 mmHg)	University medical centre, home intervention	n= 65 IG: 35 (57%) CG: 30 (57%)	IG: x̄ 54 years CG: x̄ 54 years	*Hibiscus sabdariffa* 3750 mg Decoction	Placebo	6 Weeks	-	SBP		129.4 ± 4.8	122.3 ± 10.3	**-7.2*****	**Different***		Not found	Digital sphygmomanometer / No antihypertensive treatment
											DBP		78.9 ± 7.7	75.8 ± 8.6	**-3.1***	No significant differences between groups			
(Al-Anbaki et al., 2021)	Iraq	QE Not Blind Parallel	♂♀Hypertensive patients (SBP and DBP ≥140/90 mmHg)	Health centres, home intervention	n=121 IG: 76 (40%) CG: 45 (51%)	IG: x̄ 51 years CG: x̄ 53 years	*Hibiscus sabdariffa* 10000 mg,15000 mg or 20000 mg (Depending on achievement of BP goal < 140/90 mmHg) Decoction	No treatment	6 Weeks	-	SBP		151.6 ± 11.7	128.6 ± 9.2	-23.1	**Different*****		Not reported	Manual sphygmomanometer / Stable antihypertensive treatment and no antihypertensive treatment
											DBP		93.9 ± 8.8	81.9 ± 7.7	-12	**Different*****			
(Bourqui et al., 2021)	Senegal	RCT Not Blind Parallel	♂♀Hypertensive patients (SBP between 140-180 mmHg and/or DBP 90-110 mmHg)	Community medical centres, home intervention	n=218 IG1 Tablet: 51 (24%) IG1 Infusion: 38 (21%) IG2 Compressed: 49 (18%) IG2 Infusion: 44 (29%) CG: 36 (42%)	IG1 Compressed: x̄ 53 years IG1 Infusion: x̄ 57 years IG2 Compressed: x̄ 53 years IG2 Infusion: x̄ 54 years CG: x̄ 60 years	*Hibiscus sabdariffa* IG1: 750 mg Pill IG1: 10000 mg Infusion	CG: Captopril 100 mg	24 Weeks	-	SBP	IG1 Tablet	Not clear	Not clear	**-17.4*****	IG1 vs CG	Different***	Abdominal pain (IG1=8-%) Insomnia (1%)	Digital sphygmomanometer / No antihypertensive treatment
												IG1 Infusion	Not clear	Not clear	**-21.8*****	Infusion vs Tablet	No significant differences between groups		
											DBP	IG1 Tablet	Not clear	Not clear	**Not clear*****	IG1 vs CG	**Different*****		
												IG1 Infusion	Not clear	Not clear	**Not clear*****	Infusion vs Tablet	No significant differences between groups		
(Mozaffari-Khosravi et al., 2013)	Iran	RCT S. Blind Parallel	♂♀Pre-hypertensive diabetics (SBP and DBP between 120-139/80-89 mmHg)	Research Centre, home intervention	n= 94 IG: 46 (20%) CG: 48 (25%)	IG: x̄ 52 years CG: x̄ 52 years	*Hibiscus sabdariffa* 9000 mg Infusion	CG: Green tea	4 weeks	-	SBP		123.1 ± 15.5	116.8 ± 16.3	**-6.3*****	No significant differences between groups		Not found	Mercury sphygmomanometer / Stable antihypertensive treatment
											DBP		79.4 ± 11.1	74.5 ± 9.3	**-4.9*****	No significant differences between groups			

(*continued on next page*)

Table 5 (*continued*)

Reference	Country	Study design	Participants	Settings	Sample (% male)	Age	Dose of herbal medicine/ day and galenic form	Comparison	Duration	Wash-out	Parameters	Results					Adverse effects	Others (Measuring device / Use of antihypertensive drugs)
												Mean ± SD		IGpost - IGpre (mmHg)	Mean ± SD IGpost - CGpost (mmHg)			
												IGpre (mmHg)	IGpost (mmHg)					
(Haji Faraji and Haji Tarkhani, 1999)	Iran	RCT S. Blind Parallel	♂♀Hypertensive patients (SBP between 160-180 mmHg and/or DBP 100-114 mmHg)	Hospital setting, home intervention	n = 54 IG: 31 (45%) CG: 23 (30%)	IG: x̄ 53 years CG: x̄ 51 years	*Hibiscus sabdariffa* Not clear	CG: Common tea	2 weeks	-	SBP DBP	Not clear Not clear	Not clear Not clear	**-17.61***** **-10.87*****	**Different***** **Different*****		Not reported	Mercury sphygmomanometer / Up to two antihypertensive treatments (n = 0)
(Dehkhoda et al., 2024)	Iran	RCT D. Blind Parallel	♂♀Hypertensive patients (SBP ≥ 130 mmHg and/or DBP ≥ 80 mmHg)	Medical centre hospitalisation	n = 72 IG: 36 -53% CG: 36 -57%	IG: x̄ 53 years CG: x̄ 53 years	*Hibiscus sabdariffa* 1500 mg Pill	CG: Valsartan 40 mg and Hydrochlorothiazide 12.5 mg	12 weeks	-	SBP DBP	Not reported Not reported	Not reported Not reported	**-5***** **-10*****	**Different***** **Different****	Not found	Mercury sphygmomanometer / Antihypertensive treatment	
(Kundarti et al., 2024)	Indonesia	QE Not Blind Parallel	♀Hypertensive patients (SBP and DBP ≥140/90 mmHg)	Health care centre	n = 90 IG: 45 0% CG: 45 0%	IG: x̄ 64 years CG: x̄ 68 years	Hibiscus sabdariffa 500 mg Capsule	CG: Captopril 12,5 mg e Nifedipine de 10 mg	5 days	-	SBP DBP	163.24 ± 18.54† 153.31 ± 19.87†	101.84 ± 10.67† 87.09 ± 14.07†	**-61.4***** **-66.22*****	**Different***** **Different*****	Not reported	Digital sphygmomanometer / Stable antihypertensive treatment	

CG, control group; D., double; DBP, diastolic blood pressure; IG, intervention group; mmHg, millimetre of mercury; QE, quasi-experimental; RCTs, randomized controlled trials; S., simple; SBP, systolic blood pressure; SD, standard deviation.

Age and results expressed as average.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$ represents significant difference.

† Some values have been questioned as to their plausibility and are indicated with a symbol (†). Additional checks may be necessary.

administration used in the interventions, with dosages of 1250–20 000 mg daily in decoction/infusion, including 150 mg/kg of weight, with total intake after treatment of 35 g to 1.68 kg. Doses of 250, 500–640, 750, and 1 500 mg daily were administered in soluble solution, capsule, tablet and pill, respectively. Two studies did not make the dosage and intervention time clear.

Among the RCTs, two compared interventions to placebos and seven to other treatments, the vast majority (n = 6) to antihypertensive drugs. In the case of the three QE studies, two compared controls with no treatment and the third with antihypertensive drugs.

Effects of Herbal Medicines

Garlic (Allium sativum)

When comparing the consumption of *A sativum* on BP within the group, pre- and postintervention, the studies found a reduction in BP that ranged from −2.3 to −18.1 mmHg, in SBP and −3.2 at −9 mmHg, in DBP. Of these, three studies observed a reduction only in SBP (Linoby et al., 2021; Mousa and Mousa, 2007; Vila-Nova et al., 2024) and one study did not observe a reduction in DBP at the lowest dose studied (Ashraf et al., 2013). One study found a reduction in both, but only for hypertensive patients, not for prehypertensive patients (Nakasone et al., 2013).

When comparing between groups the effects of consuming *A sativum*, five studies found a greater reduction in BP in the intervention group compared to placebo (Ashraf et al., 2013; Nakasone et al., 2013; Rahmatinia et al., 2024; Ried et al., 2018; Sobenin et al., 2009), five other studies only in SBP (Linoby et al., 2021; Ried et al., 2013, 2016; Vila-Nova et al., 2024), and one only in DBP, when compared to a control group without treatment (Bahrani et al., 2020).

Adverse effects were reported in seven articles (Ashraf et al., 2013; Dhawan and Jain, 2005; Nakasone et al., 2013; Ried et al., 2010, 2013, 2016; Serrano et al., 2023), and the vast majority are associated with symptoms of the gastrointestinal tract, namely belching, reflux, heartburn, taste sensations, constipation, diarrhoea, flatulence, abdominal distension, gastric discomfort, increased gastrointestinal motility, headache, dry mouth, and cough.

The sphygmomanometer was used as a method of measuring BP, eight studies used the digital version (Linoby et al., 2021; Nakasone et al., 2013; Rahmatinia et al., 2024; Ried et al., 2010, 2013, 2016, 2018; Serrano et al., 2023), one study a mercury version (Ashraf et al., 2013), and another a manual version. Three studies did not provide detailed information about the BP measurement method (Bahrani et al., 2020; Sindhu et al., 2022; Sobenin et al., 2009) and two were not clear (Dhawan and Jain, 2005; Mousa and Mousa, 2007).

Among the RCTs, six reported the use of antihypertensive treatment (Ried et al., 2010, 2013, 2016, 2018; Serrano et al., 2023; Vila-Nova et al., 2024) and three included only participants without antihypertensive treatment (Dhawan and Jain, 2005; Nakasone et al., 2013; Rahmatinia et al., 2024). Regarding QE articles, one study included participants taking antihypertensives (Bahrani et al., 2020) and one study only included those without treatment for BP (Ashraf et al., 2013). In total, four studies did not report the use of drugs for high BP (Linoby et al., 2021; Mousa and Mousa, 2007; Sindhu et al., 2022; Sobenin et al., 2009).

Regarding lifestyle changes, only one study recommended changing habits (Dhawan and Jain, 2005), only for the intervention group, mild lifestyle changes were suggested, such as regular walking to be followed during the study period. Most studies recommended participants maintain their daily eating/physical activity habits and especially not change their intake of garlic and onions.

Celery (Apium graveolens)

The studies investigating *A graveolens* observed a pre- and post-intervention decrease in SBP from −5 to −37.91 mmHg and in DBP from −6.54 to −15.45 mmHg, when compared to placebo; a decrease in both parameters was also observed in two studies (Shayani Rad et al., 2023, 2022). With regard to adverse effects, gastric reflux, bloating, nausea, headache and skin irritation were reported. To measure the results, the researchers used 24-hour ABPM in two studies (Shayani Rad et al., 2023, 2022) and mercury sphygmomanometer in one study (Mohsenpour et al., 2023). The authors reported the use of antihypertensive treatment by the participants in two studies (Shayani Rad et al., 2022, 2023); throughout the studies, no recommendations for lifestyle changes were provided, with the exception of one which provided a low-calorie diet plan (Mohsenpour et al., 2023).

Black Cumin (Nigella sativa)

When comparing the consumption of Nigella S in BP within the group, pre- and postintervention, the studies found a reduction in BP that ranged from −8.37 to −11.8 mmHg, in SBP and from −8.54 to −8.8 mmHg, at DBP. Of these, one study did not clarify the reduction values (Dehkordi and Kamkhah, 2008). When comparing between groups, two studies found a greater reduction in BP in the intervention group compared to placebo (Dehkordi and Kamkhah, 2008; Shoaei-Hagh et al., 2021).

No adverse effects were found in most studies (n = 3), and only one study recorded: dyspepsia, nausea, and constipation (Rizka et al., 2017).

The sphygmomanometer was used as a method of measuring BP, in the digital version (Dehkordi and Kamkhah, 2008; Rizka et al., 2017) and the manual analogue version (Shoaei-Hagh et al., 2021). One study did not provide information about the BP measurement method (Nooshirvani et al., 2018).

Regarding notification of antihypertensive medication, three studies included participants using antihypertensive treatment (Nooshirvani et al., 2018; Rizka et al., 2017; Shoaei-Hagh et al., 2021), and one study only included participants without BP medication (Dehkordi and Kamkhah, 2008).

Changes in eating and physical activity habits were recorded in two articles, which asked participants not to make lifestyle changes (Dehkordi and Kamkhah, 2008; Shoaei-Hagh et al., 2021).

Panax ginseng

When comparing the consumption of *P ginseng* in intragroup BP, the researchers observed a reduction in SBP from −3.1 to −17.4 mmHg and DBP from −2.3 to −7.1 mmHg. Of these, two studies observed a reduction only in DBP (Jovanovski et al., 2020; Rhee et al., 2011) and another study only for the highest dose studied in both BP parameters (Rhee et al., 2014). One study observed a reduction in BP only in SBP in hypertensive patients and not in individuals with white-coat hypertension (Han et al., 1998). When comparing between groups, four studies found a greater reduction in BP in the intervention group compared to placebo, for SBP (Han et al., 1998; Jovanovski et al., 2020, 2021; Mucalo et al., 2013) and DBP (Cha et al., 2016).

Adverse effects were reported in five articles (Han et al., 1998; Jovanovski et al., 2021; Rhee et al., 2011, 2014; Stavro et al., 2006), which were quite varied, namely constipation, diarrhoea, gastric discomfort, headache, nausea, dizziness, diaphoresis, dyspepsia, facial flushing, itching, tiredness, and drowsiness.

The methods used to extract results for BP were as follows: three studies used ABPM (Han et al., 1998; Jovanovski et al., 2021; Stavro et al., 2006), five studies used digital sphygmomanometers (Cha et al., 2016; Mucalo et al., 2013; Rhee et al., 2011, 2014; Stavro et al., 2005), and one study was unclear regarding the method of measuring BP (Jovanovski et al., 2020).

Most articles (n = 8) included participants using usual antihypertensive drugs, only one study included participants without treatment for BP (Cha et al., 2016).

Only one study reported lifestyle guidance, in which participants were instructed not to make changes to their daily activity, exercise, or diet patterns (Mucalo et al., 2013).

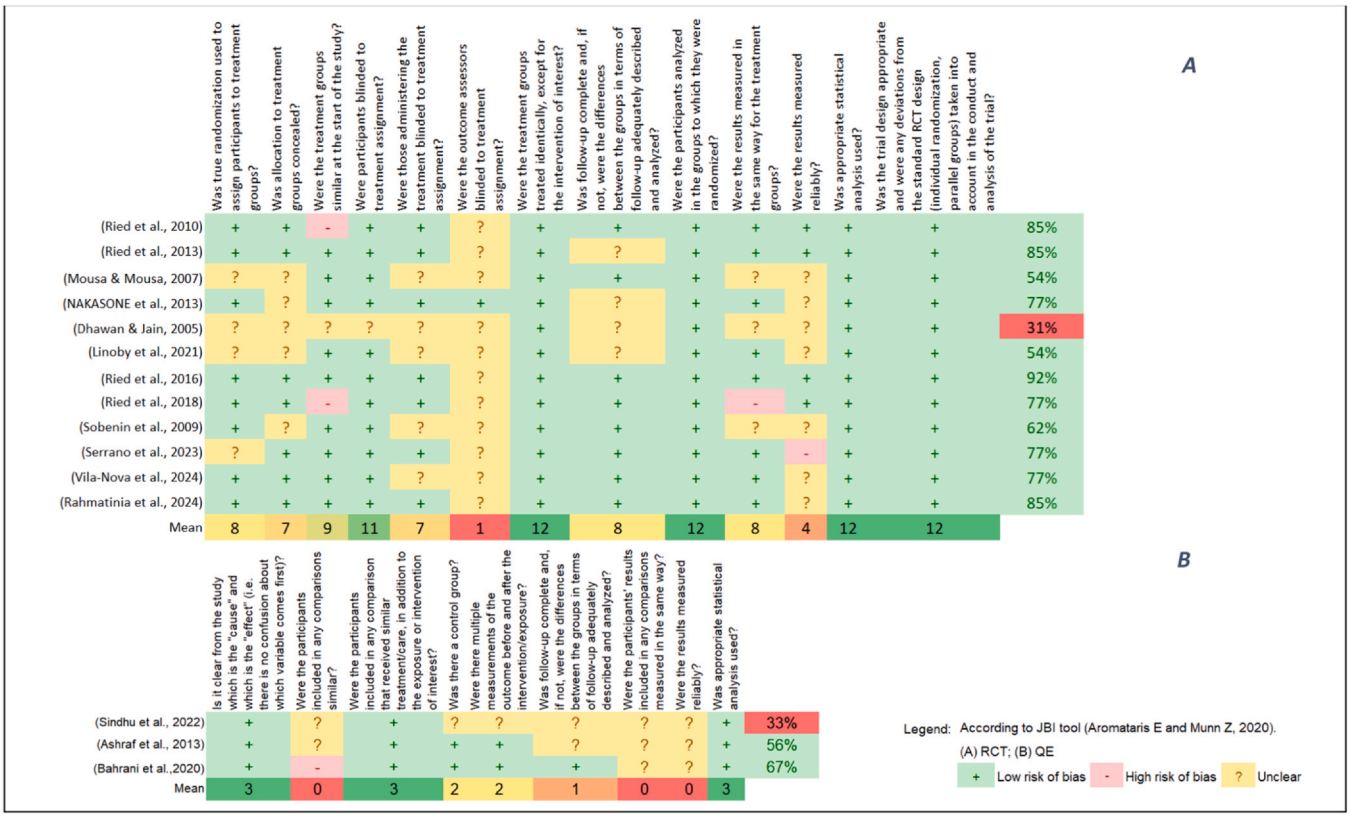

Fig. 3. *Allium sativum* studies quality.

Hibiscus (Hibiscus sabdariffa)

When comparing the effects of *H sabdariffa* consumption on BP within the group, pre-, and postintervention, the studies found a reduction in BP that ranged from −5 to −61.4 mmHg, in SBP and from −3.1 to −66.22 mmHg, in DBP. In the comparison between *H sabdariffa* and antihypertensive drugs, the results varied between the studies included. In some studies, (Bourqui et al., 2021; Nwachukwu et al., 2015, 2017), *H sabdariffa* proved to be more effective than drugs such as lisinopril, hydrochlorothiazide and captopril in reducing BP, showing statistically significant differences. In contrast, other studies (Dehkhoda et al., 2024; Herrera-Arellano et al., 2007; Seck et al., 2017) found the opposite effect, where drugs such as lisinopril, ramipril, valsartan and hydrochlorothiazide were more effective than *H sabdariffa*. In the specific case of a study comparing captopril and nifedipine, the results did not show a clear direction of difference, which limits conclusive interpretation (Kundarti et al., 2024). About a placebo group, two studies observed reductions in BP parameters (Nwachukwu et al., 2015, 2017), and a study observed only in SBP (McKay et al., 2010). When the consumption of *H sabdariffa* was compared to a group without treatment, two articles found a reduction in BP (Al-Anbaki et al., 2021; Jalalyazdi et al., 2019) and one in SBP (Yusni and Meutia, 2020). The consumption of *H sabdariffa* also demonstrated a reduction in BP values when compared to common tea (Haji Faraji and Haji Tarkhani, 1999).

Adverse effects were reported in a single article (Bourqui et al., 2021), which were abdominal pain and insomnia.

The sphygmomanometer was used as a method of measuring BP, seven studies used the analogue version, being a manual sphygmomanometer (Al-Anbaki et al., 2021; Jalalyazdi et al., 2019) and mercury (Dehkhoda et al., 2024; Haji Faraji and Haji Tarkhani, 1999; Mozaffari-Khosravi et al., 2013; Nwachukwu et al., 2015, 2017; Yusni and Meutia, 2020). Four studies used the digital version (Bourqui et al., 2021; Kundarti et al., 2024; McKay et al., 2010; Seck et al., 2017) and one study did not provide detailed information about the BP measurement method (Herrera-Arellano et al., 2007).

Among the RCTs, the majority (n = 5) included participants not treated with conventional antihypertensive therapy (Bourqui et al., 2021; Herrera-Arellano et al., 2007; McKay et al., 2010; Nwachukwu et al., 2017; Seck et al., 2017), and three reported the use of antihypertensive treatment (Dehkhoda et al., 2024; Haji Faraji and Haji Tarkhani, 1999; Mozaffari-Khosravi et al., 2013). Two articles did not report the use of drugs for high BP (Herrera-Arellano et al., 2007; Nwachukwu et al., 2015). Regarding QE articles, two studies included participants taking antihypertensives (Kundarti et al., 2024; Yusni and Meutia, 2020) and another study included participants with or without pharmacological treatment for high BP (Al-Anbaki et al., 2021).

Changes in eating and physical activity habits were recorded in two articles, the first study included advice for weight reduction and adherence to the Dietary Approach to Hypertension and guidelines for performing aerobic exercise, five days a week for 30 minutes (Jalalyazdi et al., 2019). Another study held a health awareness lecture on controlling hypertension (Al-Anbaki et al., 2021). However, some studies instructed participants not to change their daily habits (McKay et al., 2010). One study reported that no guidance was different, except intervention (Seck et al., 2017).

The Methodological Quality of the Included Trials

Of a total of 45 studies, 41 (91.1%) had a quality of more than 75% (n = 20) and 50% (n = 21) (Figs. 3–7).

The parameters that the RCTs met most rigorously were similarity between groups at baseline, blinding of participants, treatment equivalence of intervention groups, adequate description and analysis of loss to follow-up, participants analysed in the groups to which they were randomised, quality of outcome measurements, adequacy of clinical trial design and appropriate statistical analysis. The least complete or unclear descriptions were allocation concealment, blinding of administrators and outcome assessors, and the reliability of outcome measures. With regard to QE studies, the most fulfilled parameters were

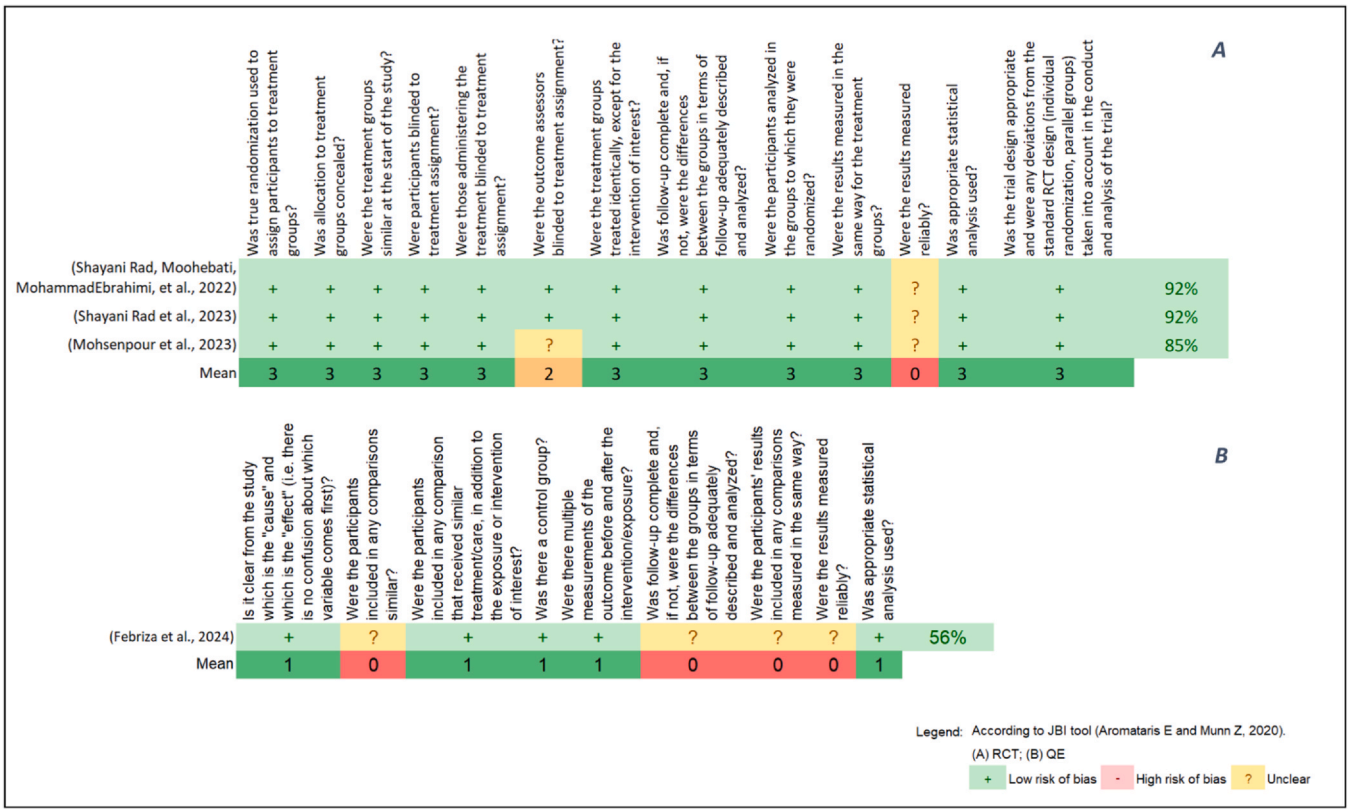

Fig. 4. *Apium graveolens* studies quality.

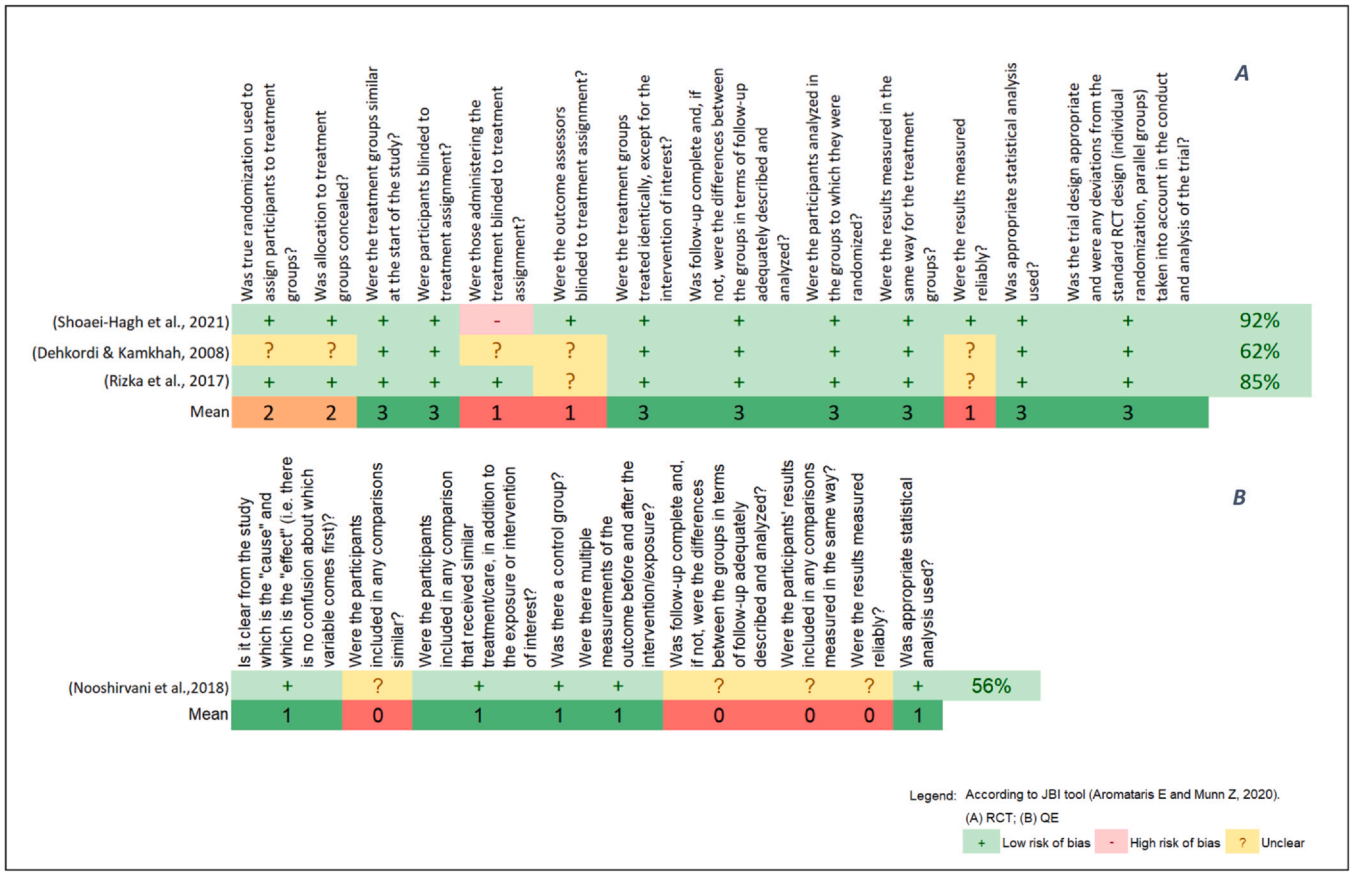

Fig. 5. *Nigella sativa* studies quality.

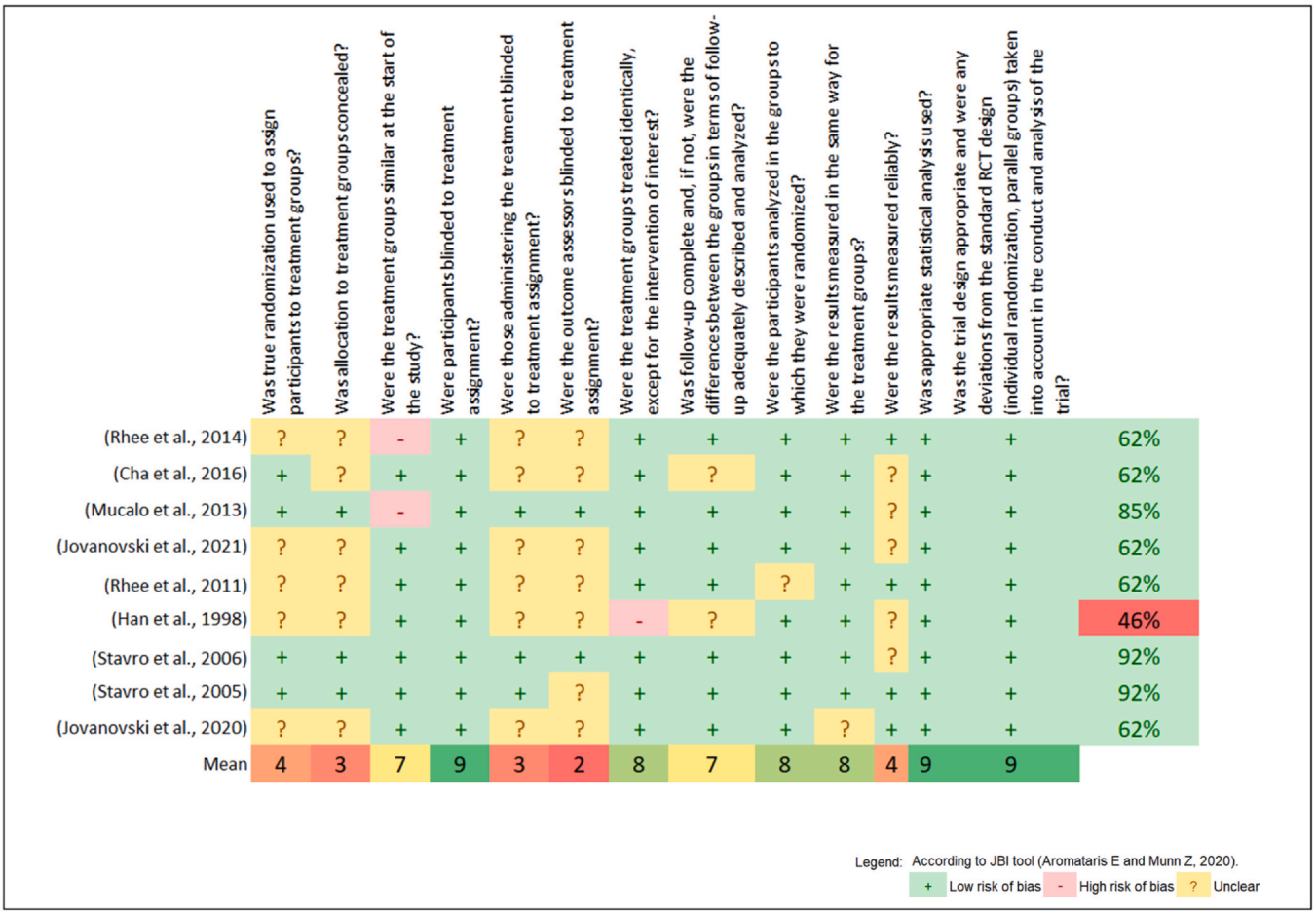

Fig. 6. *Panax ginseng* studies quality.

clarity in the identification of the causal variable and the effect variable, equivalence in the treatment of the intervention groups, the presence of a control group and the adequacy of the statistical analysis. The least satisfied or unclear descriptions were the similarity between the groups at baseline, the quality of the outcome measures and the reliability of the outcome measures.

Discussion

The purpose of this systematic review was to gather and synthesise data from experimental trials that explored the most commonly used phytotherapeutic interventions in the treatment of hypertension, in order to analyse their impact on BP in prehypertensive and hypertensive adults. It was possible to observe a hypotensive effect in all herbal medicines studied, which ranged from −2.3 to −61.4 mmHg for SBP and from −2.3 to −66.2 mmHg for DBP.

As far as we know, this systematic review is the first to carry out an exhaustive systematisation of information on the most relevant herbal medicines for the treatment of high BP.

Summary of Evidence

The antihypertensive effect varied between studies and herbal medicines and a variation in effect was found in the pre- and post-intervention of −18.1/−9 mmHg for the consumption of *A sativum*, −37.9/−15.4 mmHg *A graveolens*, −11.8/−8.8 mmHg *N sativa*, −17.4/−7.1 mmHg *P ginseng*, and −61.4/−66.2 mmHg *H sabdariffa*, for SBP and DBP respectively. The hypotensive effect was found even when the intervention group was compared to a placebo, antihypertensive drugs, and other treatments. These findings emphasise the use of herbal medicines since each decrease of 10 mmHg in SBP and 5–6 mmHg in DBP substantially reduces the risk of cardiovascular diseases (Fuchs and Whelton, 2020).

Based on the information found, *H sabdariffa* proved to be more effective than medications such as lisinopril, hydrochlorothiazide, and captopril in reducing BP, showing statistically significant differences. On the other hand, other studies indicated that medications such as lisinopril, ramipril, valsartan, and hydrochlorothiazide were more effective than *H sabdariffa*. In this same context, *A sativum* did not prove to be more effective than atenolol in reducing BP.

The galenic form showed not to influence the effectiveness of treatment with *H sabdariffa* (Bourqui et al., 2021) and with *A sativum*, being the herbal medicines that showed the greatest differences in pharmaceutical form.

Regarding adverse effects, in total, no serious symptoms were identified. However, only a comprehensive analysis of all available clinical data, including RCTs, case reports, post-marketing surveillance studies, and spontaneous reports, through systematic reviews, is able to provide reliable information on the safety of herbal medicines (Hu et al., 2020; Izzo et al., 2016).

The use of 24-hour ABPM is the most accurate method for analysing BP, compared to isolated measurements carried out by sphygmomanometer devices (Conway et al., 1988; Green et al., 2021). This is the only method capable of differentiating the white-coat hypertension (Pickering et al., 1988). The evidence presented here showed that herbal medicines did not affect the BP of white-coat hypertensive patients and BP values bordering on normotensives, perhaps being safe for these groups to include these herbal medicines in the diet and not develop hypotension (Han et al., 1998; Linoby et al., 2021; Nakasone et al., 2013; Ried et al., 2010).

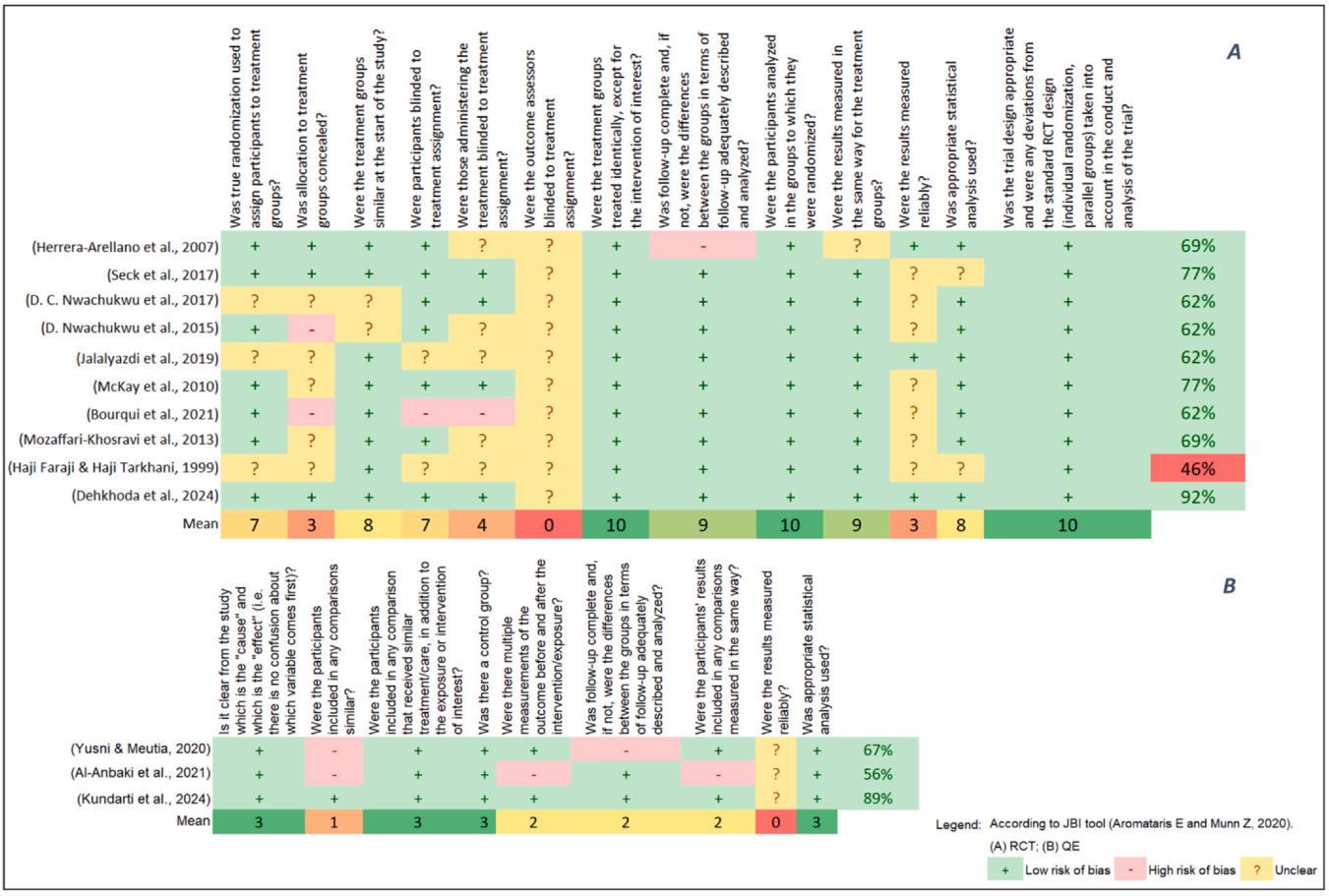

Fig. 7. *Hibiscus sabdariffa* studies quality.

It is a recognised fact that changes in diet play a fundamental role in controlling BP (Appel et al., 1997; Mulrow et al., 1998; Theodoridis et al., 2023). Although the research included demonstrates greater effectiveness for the herbal supplementation under study (Al-Anbaki et al., 2021; Jalalyazdi et al., 2019), the authors attributed the decrease in BP in the control group to the change in eating habits recommended at the beginning and during the study.

Allium sativum

A dose of *A sativum* less than 240 mg in capsule form for 12 weeks had no effects on BP (Ried et al., 2013), with the authors referring to low adherence, as did 250 mg in tablet form for the same period, with only a statistically significant difference when analysing daily changes (Serrano et al., 2023). However, a study found results that the higher the dose of 300–1 500 mg over 24 weeks, the greater the effect on BP (Ashraf et al., 2013). In this same study, the different doses did not show greater efficacy compared to the drug Atenolol.

A study included treated hypertensive patients in its sample (Ried et al., 2010), however, the number of treated and controlled hypertensive patients was higher than the uncontrolled ones. When performing a subgroup analysis, a reduction in BP was found for uncontrolled hypertensive patients (SBP −10.2 mmHg), showing that the effect of *A sativum* consumption is not observed at borderline to normotensive BP values, as two other studies have demonstrated (Linoby et al., 2021; Nakasone et al., 2013).

Extended-release and regular-acting garlic tablets have shown to be effective in reducing BP and do not differ from each other, with a dose of 600 mg daily/8 weeks being sufficient to observe significant reductions (Sobenin et al., 2009).

The mechanisms of action of *A sativum* that led to this reduction in BP have been attributed to several active sulphur compounds the ability to act as modulators of factors that promote relaxation of the endothelium, stimulating the production of nitric oxide and hydrogen sulphide, namely allicin and its inhibitory effect on angiotensin-converting enzyme (Liu and Huang, 2016; Ried, 2016).

Apium graveolens

A reduction in BP was observed with the consumption of the herbal medicine *A graveolens*. *A graveolens* showed an effect with 750 mg in capsule form and 150 ml of decoction (10 000 mg of leaf). However, research in hypertensive humans is limited, so more studies are needed to explore the mechanism of action, the dose and the optimal timing. The antihypertensive effect is attributed to n-butylphthalide, which may be responsible for the vasodilatory and diuretic effects (Alobaidi and Saleh, 2024).

Nigella sativa

Of a total of four studies included, all showed effects of reducing BP, although one study did not reach significance, this was the only one carried out in an elderly population and the authors refer to stiffness of the arteries, being a significant involvement in the pathogenesis of hypertension in the elderly, thus preventing the activity of *N sativa* (Rizka et al., 2017). The benefits in controlling hypertension related to *N sativa* are generally associated with its ability to relax blood vessels, inhibit voltage-dependent calcium channels, and reduce oxidative stress, with thymoquinone, its most active component, playing a significant role in this process (Maideen et al., 2021). More studies involving hypertensive participants are needed, as investigations into this herbal medicine are currently limited.

Panax ginseng

The Panax family consists of nine species. The main active components of *P ginseng* are the ginsenoside protopanaxatriol and

protopanaxadiol (Leung and Wong, 2010; Ratan et al., 2021), sits antihypertensive action stimulates endothelial nitric oxide and calcium-gated potassium channels. Reduces the growth of vascular smooth muscle cells induced by Angiotensin II (Jovanovski et al., 2014).

A study used a digital sphygmomanometer to collect BP in the primary analysis and found significant results about the consumption of *P ginseng* for the highest dose analysed, however, when the secondary analysis was carried out using an ABPM (24 hours), it was not significant (Rhee et al., 2014). The authors report that the pharmacological profile of *P ginseng* is partially understood due to the diversity of effects of ginsenosides. In this study, an extract rich in ginsenoside protopanaxatriol was used, which was not significant in reducing BP. Another study achieved significance using the digital sphygmomanometer, at a higher dose with this same ginsenoside (Cha et al., 2016). In our systematic review, we also observed studies with the ginsenoside protopanaxadiol that achieved significant values in reducing 24-hour BP for DBP and SBP compared to placebo (Jovanovski et al., 2021, 2020).

The study that divided hypertensive patients into two groups (hypertensive and white-coat hypertensive patients), through ABPM (24 hours), demonstrated that the consumption of *P ginseng* did not affect white-coat hypertension (Han et al., 1998).

Three articles analysed a dose of 3 000 mg daily/12 weeks, and one article analysed this daily dosage for 6 days, of which only one obtained a significant decrease in BP in both parameters (Mucalo et al., 2013). The ethanol extract used in this research was prepared to contain 10% total ginsenosides, which is considerably higher (up to 65%) compared to the amounts used in other studies. More research is needed with this same extraction process to analyse the effects on this population.

Hibiscus sabdariffa

Research that analysed the effects of consuming *H sabdariffa* differed significantly in dosage and respective comparisons. However, it was possible to observe the effectiveness of this herbal medicine in reducing BP in different pharmaceutical forms (Bourqui et al., 2021), compared with antihypertensive drugs and placebos. The antihypertensive effects of *H sabdariffa*, particularly anthocyanins, were attributed to increased production of nitric oxide, inhibition of calcium channels, and the opening of ATP-sensitive potassium channels (Alarcón-Alonso et al., 2012). *H sabdariffa* also showed diuretic effects (Hopkins et al., 2013).

Through a response-adapted dosing regimen, a study (Al-Anbaki et al., 2021) observed that 68.1% (n = 47) of participants achieved the goal of BP 140/90 mmHg with the lowest dose analysed (decoction 10 000 mg) and 31.9% needed to increase the dose, of which the majority were hypertensive patients treated with drugs. In total 61.8% (n = 76) achieved the objective compared to the health awareness lecture on hypertension control (6.7%). In correlation to other articles that studied infusions/decoctions of approximate doses to this (Bourqui et al., 2021; Jalalyazdi et al., 2019), we can observe that quantities of approximately 10 000 mg may be sufficient for a considered proportion of users.

More studies are needed to standardise the dose and time required for the hypertensive population.

Limitations

Our systematic review noted the effectiveness of the herbal medicines in question, but consideration must be given to the often-poor quality and notable variation between them.

Regarding the blinding of participants in randomised and controlled study designs, nine articles did not report it, and more than half of the studies (n = 22) did not mention the blinding of interviewers, making placebo and observer effect bias possible. Blinding of outcome assessors was not reported in 28 studies, increasing the risk of measurement bias in outcomes.

Regarding the QE studies, the selection bias was an increased risk of internal validity in these articles, since of the five studies included, three did not present similarity in the baseline between the participants. The quality of outcome measurement was not reported in two studies and one study used different instruments for assessing BP. The feasibility of ABPM 24 hours has already been mentioned above in this review, but only five articles used this method. Exclusivity and training of assessors were not reported in most studies (n = 27), this quality issue involved both RCTs and QEs.

Treatments with antihypertensive drugs were not mentioned or demonstrated in six studies, which may interfere with and confuse the effects on BP.

Some limitations were faced when performing this review, as of we decided not to include articles in languages other than English, even though we are fluent in both Portuguese and English. This choice was made to ensure that the review was feasible and accurate, since most of the relevant literature is available in English. In addition, we found it difficult to establish more precise conclusions about the dosages of herbal medicines for reducing BP. This is due to the great diversity in galenic forms, and the different dosages presented in the studies analysed, which makes it difficult to standardise dosage recommendations.

Conclusion

The herbal medicines analysed seem to have a hypotensive effect on prehypertension and hypertension, since most articles show reductions in SBP and/or DBP. The maximum reductions in BP were −18.1/−9 mmHg for the consumption of *A sativum*, −37.9/−15.4 mmHg *A graveolens*, −11.8/−8.8 mmHg *N sativa*, −17.4/−7.1 mmHg *P ginseng* and −61.4/−66.2 mmHg *H sabdariffa*, for SBP/DBP, respectively, when used alone or together with lifestyle changes or antihypertensive drugs. For the minimum effective dose on BP, *A sativum* showed a significant effect with 300 mg in pill and capsule form, 250 mg in pearls, 20 000 mg in raw form and 1 200 mg in tablet form. *A graveolens* showed an effect with 750 mg in capsule form and 150 ml of decoction (100 000 mg of leaf). *N sativa* was effective with 100 mg in capsule form and 5 ml of oil. *P ginseng* was effective with 3 000 mg capsules. *H sabdariffa* was effective with 10 000 mg decoction, 500 mg capsule, 750 mg pill and 250 mg water-soluble solution. However, the interpretation of our systematic review is crucial, due to the varied quality of studies and the specific intraphytotherapeutic disparity. More consistent clinical studies in humans are needed to precisely establish its efficacy and safety for the treatment of high BP. Furthermore, we suggest future research on the assessment of the cost-effectiveness ratio of using herbal medicines to control BP.

Author contributions

Rebeca Lachovicz: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Juliana Almeida-de-Souza:** Writing – review & editing, Supervision, Project administration. **Vera Ferro-Lebres:** Writing – review & editing, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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conduct of the research and/or the preparation of the article and the source(s) of funding did not have such involvement.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.hermed.2024.100985.

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