PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 15 (7): 633-638, 2016
ISSN 1680-5194

Effect of Garlic as a Spice on Salt Preferences of Hypertensive Individuals

Gardinia Nugrahani and Diana Nur Afifah
Department of Nutrition Science, Faculty of Medicine, Diponegoro University,
Jl. Dr. Sutomo No. 14 Semarang, Jawa Tengah, Indonesia

Abstract: Hypertension can be affected by dietary habits, such as consumption of excessive salt or foods with a high salt content. In some foods the addition of spices can lower the need for salt to maintain flavor. Moreover, the use of garlic as a spice has been shown to have anti-hypertensive effects. This study examined the effect of garlic as a spice on salt preferences of hypertensive individuals. A total of 44 hypertensive subjects were classified into two groups, a control group (n = 22) and treatment group (n = 22). Both groups were first asked to determine their preference for food samples with three different salt concentrations (0.25, 0.50 and 0.75%). Ten minutes later the two groups tasted food samples with the same salt concentrations, but garlic was added to the samples given to the treatment group. Both groups had similar physical and dietary characteristics before the treatment ($p>0.05$). Salt preferences changed from the high concentration (0.75%) to lower concentration (0.25 and 0.05%) samples for the control group (18.2%), but a higher percentage of the treatment group (31.8%) preferred the lower salt food samples when garlic was added, although this result did not reach levels of significance ($p>0.05$). These results suggest that the addition of spices such as garlic to foods may alter salt concentration preferences and promote consumption of foods with lower salt contents.

Key words: Hypertension, garlic, salt preference, appetite, salt

INTRODUCTION

Developing countries such as Indonesia have a high prevalence of non-communicable diseases that can increase the risk of cardiovascular disease, stroke and hypertension, as well as mortality from these diseases. In Indonesia hypertension is becoming more common, as evidenced by the increase in prevalence from 7.6% in 2007 to 9.5% in 2013 (Badan Penelitian dan Pengembangan Kesehatan Kementrian Kesehatan Republik Indonesia, 2013).

Diet is one cause of hypertension. Consumption of energy dense and high salt foods coupled with a lack of vegetable and fruit intake can increase the risk of hypertension (Mahanta *et al.*, 2014). Several studies showed that higher salt intake can also increase blood pressure and that reductions in salt intake can lower blood pressure in hypertensive individuals (Markota *et al.*, 2015; Zhang *et al.*, 2015; Li *et al.*, 2014). High consumption of sodium present in table salt can promote water retention and affect body fluid osmolality, which in turn increases blood volume that can lead to arterial hypertension and leg edema (Reddy *et al.*, 2015).

One study using 24 h recall of food consumption showed that the daily average sodium consumption was 198 and 161 mg in males and females, respectively. However, the sodium intake in this study was calculated only from food and did not consider intake of salt from other sources (e.g., table salt and sauces), which may have affected the findings (Thrift *et al.*, 2011).

Table salt containing sodium is often consumed as an additive or flavor enhancer in food. According to the Indonesian Society of Hypertension, Indonesians consume about 15 g of sodium per day, which exceeds the World Health Organization (WHO) recommended daily intake by about 3-fold (Choudhury, 2013; Mohan and Prabhakaran, 2013).

Research on salt preferences has been conducted using hypertensive rats as an animal model. When rats were given solutions containing salt at various concentrations, the hypertensive rats showed a preference for the solutions with a higher salt concentration (Ferrell and Gray, 1985). Another study on salt preference and salt substitutes was done with older (60-80 years old) hypertensive patients in Brazil. This study found that hypertensive patients tended to choose foods that had higher salt concentrations. However, when oregano was added to bread as a seasoning, the preferences shifted to the bread with a lower salt concentration (Villela *et al.*, 2014). Several studies showed that a high salt intake is associated with increased blood pressure (He *et al.*, 2013; Choe *et al.*, 2015), while a recent cross-sectional study conducted on 8,670 subjects found that the amount of dietary salt intake did not affect blood pressure, although this finding remains controversial (Lelong *et al.*, 2015).

The addition of herbs and spices to foods is one method by which the salt content of foods can be reduced. The presence of herbs and spices may improve food flavor and in turn increase the consumer's acceptance of that food

Corresponding Author: Gardinia Nugrahani, Department of Nutrition Science, Faculty of Medicine, Diponegoro University, Jl. Dr. Sutomo No. 14 Semarang, Jawa Tengah, Indonesia

(Ghawi *et al*., 2014). Another study found that the addition of spices may affect salt concentration preferences in hypertensive patients (Villela *et al*., 2014).

Hypertension in the Indonesian city of Semarang ranks fourth among the 10 most common diseases seen in city hospitals. In 2013, 33,440 Semarang residents suffered from hypertension, which is the highest number seen in the last five years (Dinas Kesehatan Kota Semarang, 2014). The number of cases was particularly high for patients who were between 45 and 65 years old (18.487 people). A survey conducted by Dinas Kesehatan Kota Semarang in 2013 showed that the highest incidence of essential hypertension in Semarang was at Kedungmundu medical center, which treated 5,664 cases that year (Dinas Kesehatan Kota Semarang, 2014).

The Indonesian people frequently use garlic (*Allium sativum*) as a condiment to add flavor to food. Besides its use as a seasoning, garlic is believed to have medicinal properties that can help lower blood pressure and prevent cardiovascular disease (Al-Qattan *et al*., 1999; Capraz *et al*., 2007; Jangam and Badole, 2014; Shouk *et al*., 2014; Xiong *et al*., 2015). Indeed, a study by Nakasone *et al*. (2013) on 34 pre-hypertensive patients and 47 hypertensive patients who were given 300 mg of garlic homogenates daily for 12 weeks found that systolic and diastolic blood pressure was significantly decreased (between 6.6 and 7.5 mmHg and 4.6 and 5.2 mmHg, respectively) at the end of the treatment period (Nakasone *et al*., 2013).

The objective of the present study was to determine how garlic as a spice affects the salt preferences of hypertensive individuals aged 45-60 years old who were treated at the Kedungmundu medical center in the Tembalang district of Semarang City.

MATERIALS AND METHODS

The study was conducted at the Kedungmundu medical center between November and December 2015. The study was quasi-experimental with a pre and post-test design and a randomized control group.

The subjects were screened before starting the protocol. To be included, subjects had to: (1) have hypertension (diagnosed and blood pressure measurement), (2) be between 45 and 60 years old, (3) be eating orally and 4) agree to provide informed consent. Exclusion criteria were subjects who: (1) were fasting, (2) had flu, colds, or any oral disease that would impair taste on the day of the experiment, (3) were taking medications that might alter gustatory sensitivity such as penicillin, metronidazole hydrochloride, amphotericin, nortriptyline hydrochloride, carbamazepine, biguanide, ethambutol, phenylbutazone, fluorouracil, allopurinol, penicillamine, or levodopa, or (4) resigned from the research subject.

The study was approved by the health ethics committee of the Diponegoro University Faculty of Medicine and RSUP Dr. Kariadi Semarang (Ethical Clearance no. 526/EC/FK-RSDK/2015). All subjects gave written informed consent to participate. On the day of experiment, general data for each volunteer were collected, including previous diagnoses and medication use, daily salt consumption and average sodium consumption as determined using the semi-quantitative food frequency questionnaire (SQ-FFQ) (Table 1).

The 44 hypertensive subjects were classified into 2 groups, a control group (n = 22) and a treatment group (n = 22). In the second test (post-test), subjects in the treatment group were given food samples with added garlic flavor, whereas the control group received food samples that lacked garlic in both the first and second (pre and post) tests.

The food sample was rice porridge made with rice and water at a ratio of 1:6 (wt:vol; 100 g rice and 600 ml water). Immediately after the porridge was fully cooked 0.25, 0.50 and 0.75 g salt was added per 100 g porridge to yield concentrations of 0.25, 0.50 and 0.75%, respectively. Garlic flavor was produced by adding crushed garlic to warm porridge with stirring to ensure even distribution. The garlic concentration was 1.4 g/100 g porridge (1.4%).

The different porridge mixtures were offered to the subjects in a random manner in plastic cups that were coded with random 3-digit numbers so that the enumerators involved would also be blinded to the salt content of each sample. The subjects drank room temperature mineral water between each sample. At the end of the test the subjects indicated which samples they preferred.

Ten minutes after completing the first test, treatment group subjects then tasted rice porridge with the same salt concentration (0.25, 0.50 and 0.75%) but with the addition of garlic (1.4 g/100 g of porridge). Control group subjects tasted samples with the same three salt concentrations but without garlic.

Data were reported as mean±standard deviation and analyzed statistically using Independent t tests, marginal homogeneity and the Kolmogorov-Smirnov test. Differences were considered to be statistically significant with $p<0.05$.

RESULTS

There were no differences in the clinical data characteristics between the control and treatment group subjects ($p>0.05$) in terms of systolic and diastolic blood pressure, or daily sodium intake (Table 2).

There were no significant differences in the ages of subjects in the control and treatment groups (Table 3). The subjects were divided into 3 groups according to age (45-50 years old, 51-55 years old and 56-60 years old) to examine the distribution of salt preferences.

Changes in salt preferences for the control group from high to lower concentrations were seen in the 51-55 year old group (2 persons) and the 56-60 year old group

Table 1: Study subject characteristics

	Control group (n = 22)	Treatment group (n = 22)
Sex No. (%)		
Male	4 (18.2)	4 (18.2)
Female	18 (81.8)	18 (81.8)
Add salt when cooking No. (%)		
Yes	22 (100)	21 (95.5)
No	0 (0)	1 (4.5)
Add salt at the table No. (%)		
Yes	2 (9.1)	1 (4.5)
No	20 (90.9)	21 (95.5)
Try to reduce the amount of salt consumed No. (%)		
Yes	14 (63.6)	13 (59.1)
No	8 (36.4)	9 (40.9)
Reason for reducing salt consumption No. (%)		
Health reasons	13 (59.1)	12 (54.5)
Dislike salty taste	1 (4.5)	1 (4.5)

Table 2: Clinical characteristics of control and treatment group subjects

	Control group (n = 22)	Treatment group (n = 22)	p-value
Systolic blood pressure (mmHg)	153.64±23.4	147.50±10.7	0.274
Diastolic blood pressure (mmHg)	91.0±12.83	90.91±10.1	0.897
Daily sodium intake (mg)	688.32±376.6	732.37±492.8	0.741

Table 3: Study subject ages

	Control group (n = 22)	Treatment group (n = 22)	p-value
Age No. (%)			
45-50	4 (18.2)	6 (27.3)	0.320
51-55	9 (40.9)	8 (36.4)	
56-60	9 (40.9)	8 (36.4)	

(2 persons) (Fig. 1). Meanwhile, salt preferences for the treatment group changed from high to lower concentrations for food samples with added garlic for the 56-60 year group (3 persons) (Fig. 2).

In the control group, 8 subjects changed their salt preferences from high to lower relative to their initial preference. However, there was no significant difference between the first and second salt preferences (p>0.05) (Table 4). Similarly, 10 subjects in the treatment group changed their salt preferences from higher or lower compared to their initial preference and there was no significant difference between the first and second salt preference (p>0.05) (Table 5). Furthermore, there was no significant difference (p>0.05) in salt preference between the control and treatment group that consumed food samples with added garlic (Table 6).

DISCUSSION

Among the study subjects, nearly all (97.8%) reported adding salt when cooking, while a much smaller percentage (6.8%) indicated that they added table salt when eating. This additional salt would increase the daily sodium intake due to the presence of sodium in other foodstuffs. Consumption of high sodium foods can affect blood pressure and promote hypertension (Reddy *et al.*, 2015). Many individuals know that excessive salt intake can negatively affect blood pressure, but consumers may have less information concerning processed foods that have high sodium contents and thus may be less able to control their sodium intake (Hoeft *et al.*, 2015). Although the interviews conducted in this study showed that many (61.3%) of the hypertensive patients realized that they needed to reduce salt consumption to lower their blood pressure, there still was a significant percentage of hypertensive patients who may not have realized the importance of reducing salt intake. This lack of knowledge may lead to continued consumption of high sodium diets that promote prolonged high blood pressure requiring medication to control (Nelms *et al.*, 2011).

Based on analysis of SQ-FFQ responses concerning frequent consumption of foods containing sodium, the average sodium intake of the study subjects was within normal limits (<5.000 mg). This outcome could be because most commercially processed foods were rarely consumed by the subjects, who were lower middle class. Apart from table salt and sodium in foodstuffs, another sodium source commonly used by the study subjects was monosodium glutamate (MSG) (Shi *et al.*, 2011). In this study, MSG use by the study subjects was not controlled.

The hypertensive subjects in this study mainly preferred foods with the 0.50 and 0.75% salt concentrations, while fewer subjects (6/44, 13.6%) preferred the lowest salt concentration (0.25%). In interviews subjects reported preferring foods that had a salty taste to bland food (the 0.25% salt concentration was considered to be bland by the subjects). Beyond taste reasons, subjects may have a tendency to choose less salty foods due to dietary habit. Thus, people who usually eat salty foods would prefer foods with higher salt concentrations compared to foods that are bland (Randall and Sanjur, 1981; MacFie, 1994; Barjolle *et al.*, 2013).

Table 4: Salt preferences of the control group

		Salt preference in second test				
		0.25%	0.50%	0.75%	Total	p
Salt preference in first test	0.25%	5 (22.7)	0 (0.0)	0 (0.0)	5 (22.7)	1.00
	0.50%	2 (9.1)	5 (22.7)	4 (18.2)	11 (50.0)	
	0.75%	0 (0.0)	2 (9.1)	4 (18.2)	6 (27.3)	
Total		7 (31.8)	7 (31.8)	8 (36.4)	22 (100)	

Table 5: Salt preference of the treatment group

		Salt preference in second test				
		0.25%	0.50%	0.75%	Total	p
Salt preference in first test	0.25%	0 (0.0)	1 (4.5)	0 (0.0)	1 (4.5)	0.206
	0.50%	2 (9.1)	11 (50.0)	2 (9.1)	15 (68.2)	
	0.75%	0 (0.0)	5 (22.7)	1 (4.5)	6 (27.3)	
Total		2 (9.1)	17 (77.3)	3 (13.6)	22 (100.0)	

Table 6: Salt preference for food samples with garlic

		Salt preference				
		0.25%	0.50%	0.75%	Total	p
Group	Control	7 (31.8)	7 (31.8)	8 (36.4)	22 (100)	0.621
	Treatment	2 (9.1)	17 (77.3)	3 (13.6)	22 (100)	
Total		9 (20.5)	24 (54.5)	11 (25.0)	44 (100)	

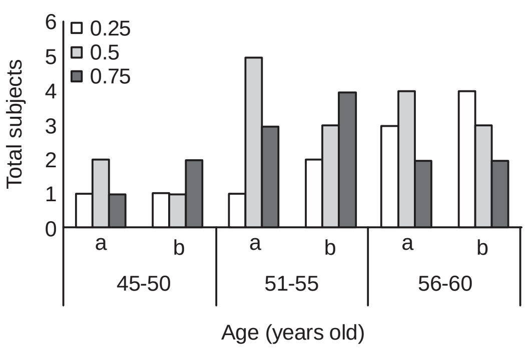

Fig. 1: Distribution of preferences for food samples in control group pre (a) and post (b) test by age

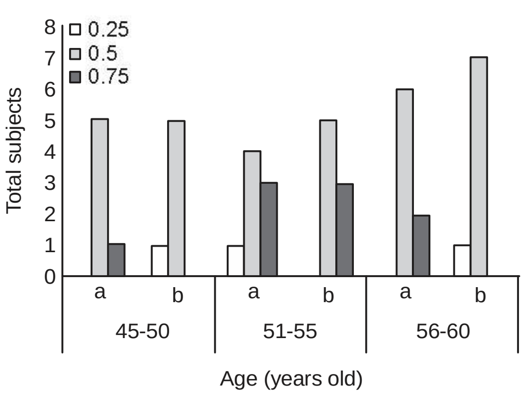

Fig. 2: Distribution of preferences for food samples in treatment group pre (a) and post (b) test by age

The decreasing sensitivity of gustatory function that occurs during aging typically has not occurred in middle age, which was the age of the study subjects (Minaker, 2012). As such, the subject's ability to taste should not be affected by age as evidenced by the subjects' ability to distinguish samples that they perceived as being too salty and not salty.

We observed changes in salt preference in the treatment group, wherein the number of subjects who preferred foods with a higher salt concentration was smaller after the treatment. However, these results were not statistically significant. As such, this study showed that adding garlic to the food samples had no effect on salt preference.

Our results may be due in part to the chemical components of garlic, which include volatile sulfur compounds that could make the garlic flavor emerge as a seasoning (Pruthi, 1998; Radulovic *et al*., 2015). The properties of these volatile compounds can be mitigated when foods are exposed to the air for long periods, to the point where added garlic flavor in food samples is less detectable (Purwaningsih, 2006; Syamsiah and Tajudin, 2003). Garlic cannot replace the salty and savory flavors that salt provides, such that foods in which garlic is added to compensate for reduced salt content cannot fully resemble the taste of food with only salt as a flavoring. Garlic is typically used as a seasoning and is important for developing a food's flavor relative to its ability to provide taste (Syamsiah and Tajudin, 2003). The garlic used in this study can have therapeutic effects in hypertension by lowering blood pressure. This effect is apparent when garlic is consumed at a dose of 300 mg for 12 consecutive weeks (Nakasone *et al*., 2013).

These results may also have been affected by age, wherein younger people (45-50 years old) may have easier access to information related to nutrition, foods and hypertension so that their knowledge level may higher than that of older people (51-60 years). This line of thinking is consistent with the theory that a person's knowledge level can affect food preferences (Qin *et al.*, 2014).

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