

Full Length Research Paper

Comparative qualitative phytochemical analysis of oil, juice and dry forms of garlic (*Allium sativum*) and different varieties of onions (*Allium cepa*) consumed in Makurdi metropolis

Esienanwan Esien Efiog^{1*}, Luavese Priscillia Akumba², Ezinne Callista Chukwu¹, Adepoju Isaiah Olusesan³ and Godwin Obochi⁴

¹Department of Biochemistry, Federal University, Lafia, Nasarawa, Nigeria.

²Department of Food Chemistry, Benue State University, Makurdi, Nigeria.

³Department of Crop Production, Federal University Wukari, Taraba State, Nigeria.

⁴Department of Biochemistry, Benue State University, Makurdi, Nigeria.

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The qualitative phytochemical analysis of oil, juice and dry forms of garlic and three species of onions (red, brown and white onions) was investigated. Samples of fresh and dried garlic, red, brown and white onions were prepared and analyzed. All the samples were analyzed for the presence of phytochemicals which include saponins, flavonoids, phenols, tannins, triterpenoids, cardiac glycosides, steroids and alkaloids. Results of the juice samples showed that garlic has the lowest phytochemical content while red and brown onions recorded the highest and similar phytochemical contents. All the samples gave positive results for saponins and cardiac glycosides. For the dry samples, garlic had the lowest phytochemicals while the red and brown onions had the highest. The oil extracts of garlic and white onions had lower phyto-nutrients while red and brown species still possessed higher phyto-nutrients with steroids and saponins present in all samples. This study concludes that brown onions has the highest phytonutrients in all forms and are recommended as the most preferred option in health and disease.

Key words: Flavonoid, tannins, saponin, phytochemical, onions, garlic, Makurdi.

INTRODUCTION

Plants have over time served mankind as sources of useful drugs, food, additives, flavouring agents, colourants, binders and lubricants (Falodun et al., 2006). Medicinal plants are sources of important drugs for

the treatment of diseases either alone or in combination with other plants (Awonubi, 1988). Chemical compounds found in plants include alkaloids, glycosides, essential oils, saponins, tannins, steroids, terpenoids, resins,

*Corresponding author. E-mail: esienanwanonline@gmail.com.

flavonoids, proteins and others. These chemical compounds are potent bioactive compounds found in parts of medicinal plants which are useful for therapeutic purposes (Soforowa, 1993; Nwadiaro and Nwachukwu, 2007). These inherent bioactive principles differ among plants owing to their biodiversity and as such they produce a definite physiological effect on the human body. Banso and Olutimayin (2001) have shown that plants comprise of a wide variety of active principles. Some of the bioactive principles of plant origin possess antimicrobial properties. Thus, the knowledge of medicinal plants is important in pharmaceutical industry and this supports their use as base for the development of new drugs.

The increased reliance on the use of medicinal plants in industrialized countries had been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal medicine (UNESCO, 1998).

Allium sativum L., is commonly called garlic. It is a perennial plant widely cultivated and belongs to the family Alliaceae and genus *Allium*. Garlic has long, flat grass like leaves and a papery hood around the flowers (Milner, 2005). The greenish white or pink flowers are grouped together at the end of a long stalk. The stalk rises directly from the flower bulb, which is the part of the plant used as food and medicine (Awonubi, 1988). The most active components of fresh garlic are alliin and an enzyme called allinase. When garlic is chewed, chopped, bruised or cut, these compounds mix to form allicin, which is responsible for garlic's strong smell. Its medicinal claims have included cures for coughs, cold, toothaches, some viral infections and open wounds (Fluck, 1973).

A. sativum Linn has been known to possess both dietary and medicinal properties (Ross et al., 2001), and it is proven to have antimicrobial effects (Reuter et al., 1996). The plant also possesses phytochemical constituents (Cavallito and Bailey, 1944). The antimicrobial properties of garlic were first described by Louis Pasteur in 1958, and since then, research had demonstrated its effectiveness against bacteria, protozoa, fungi and some viruses (Jaber and Al-Mossawi, 2007). In its pure form, it has been found to exhibit antibacterial activity against a wide range of Gram-negative and Gram-positive bacteria, including multidrug-resistant enterotoxigenic strains of *Escherichia coli* and also possesses antifungal activity, antiparasitic, and antiviral activity (Ross et al., 2001; Pai and Platt, 1992). The antimicrobial activity of garlic has been attributed to the presence of allicin (a thiosulphinates) whose removal completely renders garlic ineffective against microorganisms (Hughes and Lawson, 1991). Allicin, the main active principle related to *A. sativum* chemistry is obtained by crushing or cutting garlic cloves. The odourless amino acid, alliin present in the garlic cloves, is metabolized by the enzyme allinase (a cysteine sulphoxidelyase) to allicin and other thiosulphinates,

which besides their antimicrobial effect; produce the characteristic odour of garlic (Block, 1985). Allicin is considered to be responsible for the bacteriostatic properties of garlic. *A. sativum* extracts obtained with ethanol (ethanolic garlic extract, EGE) and acetone (acetonic garlic extract, AGE) extracted by drying at 60°C (Eja et al., 2007), and by Soxhlet apparatus (EL-Mahmood, 2009) was claimed to have direct implication in the inhibition of the *in-vitro* growth of gram positive, gram negative and diarrhoeagenic bacteria responsible for serious gastric diseases such as ulcers and even gastric cancer.

Allium cepa commonly known as onions have been valued for their medicinal qualities by many cultures around the globe. Numerous health benefits have been attributed to the vegetable, including prevention of cancer and cardiovascular disorders. Sequel to this, studies on specific compounds found in onion bulbs have been carried out (Block, 1985). Onions have a unique combination of three families of compounds that are believed to have effects on human health. They include fructans, flavonoids and organosulphur compounds. Fructans are small carbohydrate molecules that help maintain gastrointestinal health by sustaining beneficial bacteria (Eja et al., 2007). Block(1985) and Eja et al.(2007) have focused on a flavonoid- quercetin, which is found at particularly high levels in onions. It functions as an antioxidant, deactivating molecules that are injurious to cells in the body.

The organosulphur compounds are largely responsible for the taste and smell of onions. These compounds reduce symptoms associated with diabetes mellitus, inhibit platelet aggregation (involved in thrombosis) and prevent inflammatory processes associated with asthma (Hughes and Lawson, 1991).

Plant essential oils are generally of quite complex composition containing volatile components more or less modified during preparation. The volatile fractions of essential oils constitute 90–95% of the oil in weight, contains the monoterpene and sesquiterpene hydrocarbons as well as their oxygenated derivatives along with aliphatic aldehydes, alcohols, and esters (Eja et al., 2007).

Garlic and onions contain oils which are essential oils, consisting of chemical compounds which have hydrogen, carbon and oxygen as their building blocks. Essential garlic oil contains variety of sulphides such as diallyldisulphide and dilyltrisulphide. During the process of distillation, allicin is completely eliminated from the oil. Commercially available garlic oil capsules generally contain vegetable oil and a small amount of garlic essential oil because of the pungent odors (Jaber and Al-Mossawi, 2007).

Regular consumption of garlic oil can reduce blood pressure; prevent heart disease including atherosclerosis, high cholesterol and cancer. Garlic oil is an effective antibiotic, anti-viral and anti-fungal agent, which could be

used to prevent nausea, diarrhea, ease coughs and could be used even in treatment of conditions such as malaria and cholera probably an immune system enhancement (Eja et al., 2007).

Despite the nutritional and vast health benefits of the allium species, these plants are not being used by some people due to their pungent odour and irritation to the eyes. Therefore, the research was aimed at ascertaining what form (oil, juice or dried) of onion or garlic which show the presence of most phytochemical constituent which could be subsequently processed, packaged and recommended as supplement in health and disease.

MATERIALS AND METHODS

Collection of samples

A. sativum and *A. cepa* samples of the three available types— red, brown and white onions were collected from Wurukum market and Wadata markets both in Makurdi metropolis, Benue State, Nigeria.

Processing of plant materials

The collected *A. sativum* bulbs collected were cleaned thoroughly. Part of it was oven dried. The dried bulbs were blended into fine powder and stored in airtight container at room temperature. Some of the bulbs were left for oil extraction.

The collected *A. cepa* bulbs were also cleaned thoroughly, part of it was made into juice for analysis and another part was left for oil analysis.

Preparation of extracts

The organic solvents such as petroleum ether, n-hexane, chloroform, methanol and distilled water were used for the extraction of active compounds from the *A. sativum* and *A. cepa* bulbs for six hours. The extraction of oil was done using soxhlet apparatus. For every 200 mL of the each solvent, 25 g of the crushed plant leaves powder was used for Soxhlet extraction. Onions and garlic were chopped into small pieces and mashed with a domestic blender. It was then loaded into a thimble and extracted using n-hexane.

Oil extraction

The extraction of garlic oil and onion oil was conducted with a soxhlet extractor using n-hexane (boiling point of 40 – 60°C) for 6 h. The oils were obtained after the solvent was removed under reduced temperature and pressure and refluxing at 70°C so as to remove any excess solvent used for the oil extracted. The extracted oils were stored in a refrigerator freezer at 2°C for subsequent analyses (Ameh et al., 2012). This method is called soxhlet extraction or hot continuous extraction.

Juice extract

Fresh garlic and onions were chopped and blended. The pulp was diluted with distilled water and then filtered using a muslin cloth and the filtrate was analyzed for the presence of phytochemicals according to the method described by El-Mahmood (2009).

Phytochemical analyses

The oil and the dried forms of garlic extracts were analyzed for the presence of different phytochemicals. In a similar way, the oil and juice from the different species of onions (red, brown and white) were analyzed for the presence of phytochemical compounds. The analysis of these phytochemical compounds was done based on the methods described by Gazuwa et al. (2013)

Phytochemical analysis on the oil, dry and juice of garlic and red, brown and white onion species was done using standard qualitative procedures; Dragendorf test for alkaloids, sodium hydroxide test for flavonoids, ferric chloride test for tannins, Salkowski test for cardiac glycosides, Liebermann-Burchard test for terpenes, general test for saponins and phenols etc.

Test for saponins

Three milliliters (3ml) of aqueous extract was diluted with 20 ml of distilled water and shaken in a graduated cylinder for 15 min. The formation of a layer of foam measuring about 1 cm indicates the presence of saponins (Singh and Chauhan, 2014).

Test for flavonoids

Two milliliters (2 ml) of dilute sodium hydroxide was added to 3 ml of extract in a test tube. A yellow solution that turns colourless on addition of concentrated HCl indicates the presence of flavonoids (Prashanth and Krishnaiah, 2014).

Test for phenolic compounds and tannins

Three milliliters (3 ml) of oil, juice and dried extracts were tested with 3% ferric chloride; the presence of a dark green colour indicates the presence of phenolic compounds. Also, about 2 ml of extract was tested with few drops of 10 % ferric chloride added gradually. A blue-black or blue-green precipitate shows the presence of tannins (Itelima et al., 2016).

Test for triterpenoids and steroids

Few drops of concentrated H₂SO₄ were added to a small portion of aqueous extract in a test tube and shaken. Formation of a yellow colored layer indicates the presence of triterpenoids while a red colour indicates the presence of steroids (Prashanth, Krishnaiah, 2014).

Test for cardiac glycosides

A small portion of aqueous extract was poured in a test tube, 2 ml of glacial acetic acid, a drop of ferric chloride solution and 2 ml of conc. H₂SO₄ were added. A brown ring formation at the interphase indicates the presence of cardiac glycosides (Singh and Chauhan, 2014).

Test for alkaloids

A small portion of aqueous extract was poured in a test tube, few drops of 1% HCl were added followed by the addition of Mayer's reagent. Formation of a white or creamy precipitate indicates the presence of alkaloids (Prashanth and Krishnaiah, 2014).

Table 1. Phytochemical analysis of juice forms of garlic and three onion species.

Phytochemical	Garlic	Red onions	Brown onions	White onions
Flavonoids	-	+	+	+
Phenols	-	+	+	+
Tannins	-	+	+	+
Triterpenoids	-	+	+	-
Steroids	-	-	-	-
Cardiac glycosides	+	+	+	+
Alkaloids	+	-	-	-
Saponins	+	+	+	+

+, Present; -, Absent.

Table 2 Phytochemical analysis of the dry forms of garlic and the three onion species.

Phytochemical	Garlic	Red onions	Brown onions	White onions
Flavonoids	-	+	+	-
Phenols	-	+	+	+
Tannins	-	+	+	+
Triterpenoids	-	-	-	+
Steroids	+	-	+	-
Cardiac glycosides	+	+	+	-
Alkaloids	-	-	-	-
Saponins	+	+	+	+

+, Present; -, Absent.

Table 3. Phytochemical analysis of oils from the samples.

Phytochemical	Garlic	Red onions	Brown onions	White onions
Flavonoids	-	+	+	-
Phenols	-	+	+	-
Tannins	-	+	+	-
Triterpenoids	-	+	+	-
Steroids	+	+	+	+
Cardiac glycosides	+	+	+	+
Alkaloids	+	-	-	+
Saponins	+	+	+	+

+, Present; -, Absent.

RESULTS

The results of the qualitative phytochemical analysis for the juice forms of garlic and three onion species (red, brown and white onions) were analyzed.

Result from Table 1 shows that red and brown onion juice had a greater distribution of phytochemicals when compared with other samples. Garlic juice had the lowest distribution of phytochemicals. Saponin and cardiac glycosides was present in all samples while steroids was absent in all juice samples.

Results from Table 2 shows that dry brown onions had a better distribution of phytochemicals and was followed closely by dry red and white onion samples respectively. Dry garlic recorded the lowest phytochemical distribution. Saponin was present in all samples while alkaloid was absent in all samples.

From Table 3, oil samples of red and brown onion had the same phytochemical composition and distribution when compared with white onions and garlic. Steroids, cardiac glycosides and saponins were present in all oil samples.

Table 4. Comparison of the different forms of garlic samples.

Phytochemical	Juice	Dry	Oil
Flavonoids	-	-	-
Phenols	-	-	-
Tannins	-	-	-
Triterpenoids	-	-	-
Steroids	-	+	+
Cardiac glycosides	+	+	+
Alkaloids	+	-	+
Saponins	+	+	+

+, Present; -, Absent.

Table 5. Comparison of the different forms of red onions.

Phytochemical	Juice	Dry	Oil
Flavonoids	+	+	+
Phenols	+	+	+
Tannins	+	+	+
Triterpenoids	+	-	+
Steroids	-	-	+
Cardiac glycosides	+	+	+
Alkaloids	-	-	-
Saponins	+	+	+

+, Present; -, Absent.

Table 6. Comparison of the different forms of brown onions.

Phytochemical	Juice	Dry	Oil
Flavonoids	+	+	+
Phenols	+	+	+
Tannins	+	+	+
Triterpenoids	+	-	+
Steroids	-	+	+
Cardiac glycosides	+	+	+
Alkaloids	-	-	-
Saponins	+	+	+

+, Present; -, Absent.

Table 4 shows the comparative phytochemical distribution of all forms (juice, dried and oil) of garlic samples. Flavonoids, phenols, tannins and triterpenoids were absent in all forms. Cardiac glycosides and saponins were present in all forms.

From Table 5, flavonoids, phenols, tannins, Cardiac glycosides and saponins were present in all forms (juice, dried and oil) of red onion samples while alkaloids were absent in all red onion samples.

Results from Table 6 reveals the presence of flavonoids, phenols, tannins, cardiac glycosides and saponins in juice, dry and oil samples of brown onions. Alkaloids was absent in all samples.

From Table 7, juice, dry and oil samples of white onions showed varying presence of phytochemicals. Phytochemicals were present more in the juice than in the oil and dry forms. Saponin was present in all samples.

Table 7. Comparison of the different forms of white onions.

Phytochemicals	Juice	Dry	Oil
Flavonoids	+	-	-
Phenols	+	+	-
Tannins	+	+	-
Triterpenoids	-	+	-
Steroids	-	-	+
Cardiac glycosides	+	-	+
Alkaloids	-	-	+
Saponins	+	+	+

+, Present; -, Absent.

DISCUSSION

Garlic, red, brown and white onions showed the presence of varying number of phytochemicals. This confirmed a similar qualitative work on garlic and onions by Gazuwa et al. (2013). Comparing the juice from the four samples, as seen in Table 1, garlic had the lowest number of phytochemicals and was closely followed by white onions. Red and brown onions showed similar phytochemical contents and both recorded the highest of the four samples. Steroids were absent in all samples while cardiac glycosides and saponins were present in all samples. These results are in tandem with studies carried out by Ameh et al. (2012). This result suggests a rich presence of phytonutrients with cardioprotective and antihypertensive potentials. Cardioprotective and antihypertensive properties of garlic were reported by Asdaq and Inamdar (2011) and Bhandari (2012). Cardioprotective and antihypertensive properties of onions was confirmed by Lanzotti (2006).

From Table 2, garlic also had the lowest number of phytonutrients followed by red and white onions with brown onions having the highest number of phytonutrients. Here, triterpenoids and alkaloids were absent in all samples while saponins were present in all samples. This is in consonance with studies done by Eja et al. (2007). This suggests the presence of phytochemicals with antimicrobial, antifungal, hypolipidemic and anticancer potentials. These phytochemicals have been reported by Sengupta et al. (2004) to have anticancer properties. Dried brown onions possessed the highest number of phytochemicals and may be considered as an antibiotic treatment option above others. The antimicrobial activity of allium species have been reported (Reuter et al., 1996; Ross et al., 2001; Bhandari, 2012).

The results of the oil samples from Table 3 shows garlic and white onions had lower number of phytonutrients when compared with red and brown onions which recorded the highest number of phytonutrients. Research has proven that Allium oils have high antioxidant and antibacterial activity (Mnayer et al.,

2014). Steroids, cardiac glycosides and saponins are present in all the samples. This conforms to the work done by Dronet al. (1997), thus, suggesting a very rich amount of phytonutrients with heart health benefits, anti-cancer potentials and hypolipidemic potentials. Red and brown onions oils can therefore be recommended as preferred sources of nutrients for remedy of these diseases since they have the highest phytochemicals.

The results of the individual samples in their different forms are shown in Tables 4 to 7. Comparison was done for the three garlic samples. The result from Table 4 shows that garlic oil had the highest phytochemical content when compared with the juice and dry forms which recorded similar findings. Cardiac glycosides and saponin were present in all samples while flavonoids, phenols, tannins and triterpenoids were absent in all samples. Although, garlic in its different forms can be used as remedy for cardiovascular disease, hypertension and cancer due to their phytochemical content, garlic oil can be used as preferred source over the other forms. Orengo et al. (2016) also confirmed the presence of these active components in onion and garlic.

The results of Table 5 show that the oil sample of red onions had the highest number of phytochemicals followed by the juice, while the dry form had the least number of phytochemicals. Here flavonoids, phenols, tannins, cardiac glycosides and saponins are present in all forms while alkaloids are absent in all forms. This conforms to a study conducted by Dini et al. (2008).

Table 6 also shows the oil form of brown onions had the highest number of phytochemical nutrients while the juice and dry forms followed closely. Here also, flavonoids, phenols, tannins, cardiac glycosides and saponins are present in all forms while alkaloids is absent in all forms. Ogbonna et al. (2016) confirmed the presence of these phytochemicals in onion samples. Brown onion samples can therefore be used in similar manner as the red onions. Here also the oil sample had slightly more number of phytonutrients than the juice and dry samples.

Results from Table 7 show white onions juice had the highest number of phytochemical content when compared

with the dry and oil samples. These results support the findings of Dini et al. (2008). Saponin was present in all samples.

In comparison, the oil extracted from garlic contains slightly more number of phytochemicals than the juice and dry forms, likewise the red onions and the brown onions. However, the juice form of the white onions had slightly more number of phytochemicals than the oil and dry forms. Different authors have linked the antimicrobial analysis of plants to the presence of phytochemicals. Nwadiaro and Nwachukwu (2007) linked the antimicrobial activity of plants to the presence of tannins, alkaloids, flavonoids and saponins. Also, qualitative phytochemical analysis of garlic and onions has been done by different researchers with positive results for different phytonutrients.

Conclusion

The results of these analyses show that both garlic and onions possess varying number of phytochemicals. The juice and dry forms of brown onions had greater number of phytochemicals followed by red, white onions and garlic respectively. The oil of brown and red onions had the highest number of phytochemicals. The oil of garlic, red and brown onions had the highest number of phytochemicals while the juice form of white onions had the highest number of phytonutrients. This study thus concludes that brown and red onions had the highest number of phytonutrient.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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