Production and quality evaluation of garlic (*Allium sativum*) vinegar using *acetobacter aceti*

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Abstract: A process was developed for the preparation of garlic vinegar. The prepared product was analyzed for different parameters and found that pH was 2.2±0.1, total solid % 10.16± 0.2, total ash 0.231± 0.025, total acidity (acetic acid) 5.52± 0.03, malic acid± 0.64± 0.1, volatile acids % 1.42± 0.3, non-volatile acids % 4.1± 0.2, oxidation value 424 ± 0.5, alkaline oxidation value 4.8 ± 0.45, acid value (KOH/kg) 14.2 ± 0.1, saponification value 31.23± 0.2, peroxide value nil, iodine value 20 ± 0.4,ethanol content nil, ester value 29.6± 0.3. The minerals composition showed that Sodium (g/100g) 5.8997±0.2, Potassium (mg/100g) 218.78± 0.03, Calcium (mg/100g) 15.2212 ± 0.04, Magnesium (mg/100g) 23.1315± 0.1, Phosphorus (g/100g) 4.2511 ± 0.5 and iron (mg/100g) 2.156± 0.11. The prepared garlic vinegar was a good sensory evaluation when compared to branded vinegar.
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Key words: Garlic vinegar, chemical composition, sensory evaluation, and mineral composition

Introduction

Vinegar, from the French *vin aigre*, meaning "sour wine," can be made from almost any fermentable carbohydrate source, including wine, molasses, dates, sorghum, apples, pears, grapes, berries, melons, coconut, honey, beer, maple syrup, potatoes, beets, malt, grains, and whey. Initially, yeasts ferment the natural food sugars to alcohol. Next, acetic acid bacteria (*Acetobacter*) convert the alcohol to acetic acid (vinegar 2006). The wide variety of vinegars available today is nothing new. Until the six century BC, the Babylonians were making and selling vinegars flavored with fruit, honey, malt, etc. to gourmets of the time. In addition, the Old Testament and Hippocrates recorded the use of vinegar for medicinal purposes (Kehrer 1921; Conner 1976). The potency of garlic (*Allium sativum*) has been acknowledged for >5000 years. In ancient times, the Babylonians, Egyptians, Phoenicians, Vikings, Chinese, Greeks, Romans and Hindus used garlic frequently (Block 1985). They took garlic as a remedy for intestinal disorders, flatulence, worms, respiratory infections, skin diseases, wounds, symptoms of aging and many other ailments. The use of garlic to treat wounds surfaced repeatedly through the middle ages into World War II, when garlic was used to treat the wounds of soldiers Garlic was ground or sliced and was applied directly to wounds to inhibit the spread of infections (Essman 1984). Garlic products have experienced increasing popularity in the last decade. Garlic preparations have been shown to exhibit hypolipidemic, antiplatelet and procirculatory effects. Aged garlic extract (AGE), along with other garlic preparations, has been reported to possess hepatoprotective, immune-enhancing, anticancer and chemopreventive activities. Furthermore, AGE exhibits antioxidative activities, whereas raw or heated garlic stimulates oxidation (Imai *et al.* 1994). Keeping in view of the beneficial effects of garlic it is aimed to develop a process for the production of garlic vinegar and compared this to the branded vinegar.

Materials and methods

Culture collection

Vinegar culture *Acetobactor aceti* after isolation, identification and characterization was produced in Food Microbiology Laboratory, PCSIR Labs. Complex, Peshawar.

Fermentation process

The low quality garlic (*Allium sativum*) were purchased from local market were cut into pieces and passed through juicer machine. The brix of juice was adjusted to 16º. Yeast was added and pH was adjusted to 4-4.5.The juice was transferred to fermenter and temp was adjusted at 37ºC. The slurry was converted to alcohol after 5-7 days. When fermentation was completed. Alcohol was decanted. Culture of *acetobacter aceti* was added to decanted alcohol and shifted to acetater. The temperature of acetater was adjusted at 30ºC and kept at this temperature for 20 days. Samples were examined for aroma and acidity on daily basis until specific aroma and acidity for vinegar preparation was achieved.

Chemical analysis of Apple Cider vinegar

Chemical analysis PH, total solid %, total ash%, total acidity (Acetic acid), malic acid, volatile acids%, non volatile acid%, oxidation value, alkaline oxidation

value, acidic value (KOH/kg), saponification value, peroxide value, iodine value, ethanol contents and ester value of apple cider vinegar and branded samples were determined according to the standards methods [7].

Minerals composition of Apple Cider vinegar

Atomic Absorption Spectrophotomer followed by standards methods[7] determined sodium, potassium, calcium, magnesium, phosphorus and iron.

Sensory evaluation of Apple Cider vinegar

In order to check the overall acceptability of vinegar, the samples were subjected for sensory evaluation i.e. colour, flavour, taste and overall acceptability by a panel of trained judges using the 9-point Hedonic scale [8].

Result and Discussion

The results of physiochemical analysis of garlic vinegar were shown in Table1. The result of pH was 2.2±0.1. The result obtained was similar to recommendations of Rehm and Reeed7 who recommended that vinegar has a pH range of 2.35 to 2.45. The vinegar produced from pineapple peels8 has a pH 2.8. The result obtained for total soluble solids was 10.16±0.2. The total ash content in the garlic vinegar was 0.231±0.025, the ash in the product was due the inorganic materials (minerals) in the product. Total acidity in terms of acetic acid of garlic vinegar was 5.52±0.03. The acidity of vinegar is still due to the presence of acetic acid. The malic acid %, volatile acids% and non-volatile acids% were 0.64±0.1, 1.42±0.3 and 4.1±0.2 respectively. All volatile organic acids short chain affects the acidity, flavor and quality of vinegar. These volatile acids, mainly acetic acids and smaller propionioc and butyric acid come from raw materials or are generated by fermentation9. According to Walter[10] acetic acid and other organic acids (for example: citric acid, tartaric acid, malic acid, succinic acid and lactic acid) determine the acidity of vinegar. In garlic vinegar the malic acid (0.64±0.1) was low as compared to onion vinegar (47.5mg/100ml), alcohol vinegar (6.41mg/100ml), apple vinegar 6.53mg/100ml and wine vinegar 20.3mg/100ml. Garlic vinegar malic acid value was closely related to value of rice vinegar and malt vinegar have a very low malic acid content (0.06mg/100ml) as compared to our finding[10].The oxidation value, alkaline oxiadation value, acidic value (KOH/kg), saponification value, peroxide value, iodine value and ester value of garlic vinegar were 424±0.5, 4.8±0.45, 14.2±0.1, 31.23±0.2, nil, 20.0±0.4 and 29.6±0.3 respectively. Most of the total sugar was converted to acitic acid via ethanol. The ethanol content in garlic vinegar was nil and onion vinegar[10] have 2g/l.

Table 2 describes the main mineral composition of garlic vinegar. The sodium content in garlic vinegar was 5.8997g/100g, the sodium concentration in various vinegar (malt, rice and other vinegars)[11] were 3100(mg/l), 2900(mg/l) and 26.8(mg/l) respectively. The potassium concentration of garlic vinegar was high (218.78±0.03mg/100g) as compared to the others vinegar[11]. The garlic vinegar calcium (mg/100g), magnesium (mg/100g), iron (mg/100g) and phosphorus (g/100g) composition were 15.22±0.04, 23.1315±0.1, 2.156±0.5 and 4.2511±0.5 respectively. The studied carried out by preparation malt vinegar[11] show that mineral composition (mg/l) calcium, magnesium and iron were 20,10 and 1 respectively and in another study[11] the mineral composition (mg/l) calcium, magnesium and iron in rice vinegar were 20,50 and 10 respectively. The result regarding sensory evaluation was present in Table 3. The sensory evaluation plays an important role in the quality of food. The overall acceptability of garlic vinegar was 8.5 score, which were comparable to other branded vinegar samples.

Table.1 Chemical analysis of Garlic vinegar

S#	Parameters	Results
1	PH	2.2±0.1
2	Total solid %	10.16±0.2
3	Total Ash%	0.231 ±0.025
4	Total acidity (Acetic acid)	5.52 ±0.03
5	Malic acid	0.64 ±0.1
6	Volatile acids%	1.42 ±0.3
7	Non volatile acid%	4.1 ±0.2
8	Oxidation value	424 ±0.5
9	Alkaline oxidation value	4.8 ±0.45
10	Acidic value (KOH/kg)	14.2 ±0.1
11	Saponification value	31.23 ±0.2
12	Peroxide value	Nil
13	Iodine value	20 ±0.4
14	Ethanol contents	Nil
15	Ester value	29.6 ±0.3

Table.2. Mineral Composition of Garlic vinegar.

S#	Minerals	Garlic vinegar
1	Sodium (g/100g)	5.8997 ±0.4
2	Potassium (mg/100g)	218.78 ±0.03
3	Calcium (mg/100g)	15.2212 ±0.04
4	Magnesium (mg/100)	23.1315 ±0.1
5	Phosphorus (g/100g)	4.2511 ±0.5
6	Iron (mg/100g)	2.156 ±0.5

Table. 3 Sensory Evaluation of Vinegar.

Name of vinegar	Color	Flavour	Taste	Overall acceptability
Garlic vinegar	8.2	8.4	8.2	8.5
Branded vinegar 1	8.1	7.8	8.3	9.1
Branded vinegar 2	8.3	8.5	8.4	9.2
Branded vinegar 3	8.4	8.8	8.5	8.7
Branded vinegar 4	8.5	8.6	8.6	8.6
Branded vinegar 5	8.0	8.3	8.1	8.1
Branded vinegar 6	8.7	8.7	8.2	8.2

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