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PRODUCTION AND CHARACTERIZATION OF WINE FROM GINGER, HONEY AND SUGAR BLENDS

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ABSTRACT
In present investigation, ginger (*Zingiber officinale*), sugar and honey were used in the preparation of wines using baker's yeast strain *Saccharomyces cerevisiae*. Ginger extract was mixed with sugar, sugar: honey and honey only at different concentration to obtain fourteen wine versions. Each version was inoculated and fermented for 11 days. After fermentation the wine was clarified. Parameters like acidity, pH, alcohol and sugar content of the wines were checked every 24 hr. Most enological and physiological parameters were stable across the wine versions. Sensory and non sensory evaluation was done on all wine versions. Conclusively, wine version GH4 has maximum ethanol percentage (13.2%) where only honey was used as a source of fermentable sugars in contrast to sugar: honey and only sugar recipes with their alcohol content being 12.86 % and 11.76%, respectively. Overall acceptability of GH5, GH8 and BS3 was found to be maximum. All wine versions were acidic, having low to high alcohol content and sweet except wine version BS5. Calories of wine depend upon the concentration of sugar and honey added into the mashes.

KEYWORDS: Alcohol, fermentation, ginger, honey, wine, *Zingiber officinale.*

INTRODUCTION

Wine is one of the functional fermented foods that have many health benefits. Commercially, wine is produced by yeast fermentation which involves the conversion of sugar to alcohol. Wine can act as a health supplement attributed to polyphenols, flavonoids, minerals *etc*. extracted from fruits and vegetables during the process of fermentation. Ginger (*Zingiber officinale Rosc.*) is commonly called 'Ale' or 'Adrak' which is an important commercially grown crop for its aromatic rhizomes which are used as a spice, condiment and as a medicine. Ginger has many biological and medicinal properties. It is used in pharmacology because of low toxicity. Ginger is antitumor, antioxidant, anti-inflammatory, anti apoptotic, cytotoxic, antiproliferative and antiplatelet activities (Sekiwa *et al*., 2000; Wei, *et al*., 2005; Young *et al*., 2005; Shukla and Singh, 2007). Ginger rhizome contains phenolic ketones like gingerols as well as the shogaols. The main pungent bioactive substances extracted from the rhizomes were 6 Gingerol (Most pungent compounds), 8 Gingerol and 10 Gingerol (Leverington, 1975; Connell and Sutherland, 1969; Govindarajan, 1982). Ginger is produced by many countries. China and India are considered to be the top countries for its production (Bartley and Jacobs, 2000). Ginger is cultivated in almost all the tropical and subtropical parts of India, especially ain Maharashtra, Kerala, Karnataka, Tamil Nadu, West Bengal, Bihar, Himachal Pradesh, Uttar Pradesh *etc*. The total annual production in India is estimated about 33,780 tones. Ginger is grown in an area from almost the sea level up to an altitude of 1,500 - 1800 meters. It grows well on a variety of soils. It needs well-distributed rainfall or irrigation and adequate drainage facilities. Ginger after growing for 6-8 months can be harvested any time or even it may be kept as it is as a ratoon crop for the next year and harvested in second season to get more yield. The ginger is becoming major cash crop now a day for farmers. But in humid and heavy rain season it gets decayed due to moist environment in short period of time. Actually Indian farmers are not able to avail proper transportation facility for ginger. So Indian farmers are not getting good profit by ginger production and it's very hard to achieve the returns of their investment. So, if ginger is used for zinger wine production then farmer will get good market and profit from the ginger crop. Hopefully, it will help to change their socioeconomic status. Ginger has many health benefits, so the proposed work will be focused on the preparation of good quality of wine from ginger, honey and sugar blend by using baker's yeast. Honey was used in the ginger wine due to many reasons. According to National Honey Board, Honey contains sugars like fructose (38.2%), glucose (31%) and water (17.1%) which make it suitable substrate for fermentation. Mead is the honey wine prepared by different fermentation technology (Kraus, 2012). In the beverage industry, honey is used as a sweetener, probiotic, raw material, clarifying agent, antioxidant, flavor enhancer due to acidic nature (pH 3.9), antimicrobial activity and most importantly attract consumers (Mundo *et al*., 2004). In many beverages, off-flavors can be masked with the use of honey (Isabel *et al*., 2012). The compounds found in some honeys are the same compounds that have been proven to provide antioxidant

and anti-inflammatory benefits in both in-vitro and in-vivo studies (Josè *et al*., 2013). So, after evaluating the medicinal properties and other genuine problems of farmers, ginger and honey blend was used for wine production with the following objectives:

1. To determine optimum amount of ginger, honey and sugar in fermentation mash for wine making
2. To determine the enological and physiochemical properties of ginger honey wine
3. To evaluate sensory and non sensory characteristics of ginger honey wine

METHODS & MATERIALS

Sample Collection/Preparation

A total of 1 kg of freshly harvested honey was purchased from a local honeybee farmer and ginger was purchased from local market of Hisar, Haryana. Honey and ginger were transported in clean plastic bottles ($<4^0$C) and plastic bags, respectively, to the biotechnology laboratory, Govt College, Hisar. Honey and ginger were stored at refrigerator and room temperature, respectively, prior to preparation and fermentation.

Preparation of Starter Culture for inoculation

From the laboratory repository, pure colonies of *S. cerevisiae* (starter culture) were confirmed in potato dextrose broth (PDB) media. These cultures were then incubated at ambient temperature for one day. The starter cultures were prepared in sterile honey–ginger mixture juices for 5h, standardized, and stored at 4^0C.

Optimization of TSS and amount of ginger, sugar and honey in the fermentation mash

Preparation of mash

First of all, ginger was taken, washed and its skin was removed by using a knife. Then, ginger was flaked by using iron mortar and pestle. The sugar syrup was prepared with warm water and stained with muslin cloth. The honey was heated a little bit to remove its viscosity. The different fermentation mash was prepared with ginger, honey and sugar at varying concentration as shown in table 1.

TABLE 1: Composition of different mashes

Mash	Ginger (%)	Honey/ Sugar	Initial TSS (^{0}Brix)
GH1	4	Honey only	20
GH2	4	Sugar only	20
GH3	4	Sugar: Honey	20
GH4	6	Honey only	20
GH5	6	Sugar only	20
GH6	6	Sugar: Honey	20
GH7	8	Honey only	20
GH8	8	Sugar only	20
GH9	8	Sugar: Honey	20
BS1	6	Sugar only	15
BS2	6	Sugar only	18
BS3	6	Sugar only	22
BS4	6	Sugar only	24
BS5	6	Sugar only	26

The TSS of these mashes was adjusted with addition of sugar syrup and pH was adjusted to 3.5 by using 5% sodium bicarbonate and citric acid solution with pH meter. All these mashes were pasteurized by heating to 70-72^0C for 15 minutes and brought it to room temperature by cooling in tap water. Before inoculation, Potassium metabisulfite was added in the mashes so that bacterial contamination can be reduced.

Pitching and agitation

Prepared mash was inoculated with baker's yeast at the rate of 1g/litre and was filled into clean and boiled bottle up to 2/3rd of their capacity. The bottles were then plugged by cotton, agitated and kept for fermentation at room temperature.

Fermentation

The progress of fermentation was monitored by measuring the drop of TSS. After five days of pitching the TSS of fermented mash was measured by hand refractometer everyday till constant TSS was obtained. After 10 days of pitching, the fermentation was assumed to be completed when the TSS cease to drop further.

Determination of the physiochemical properties of ginger honey wine

Physicochemical parameters like acidity, temperature and pH were determined by using the methods of A.O.A.C. (1990). pH was determined with pH portable digital device (Jenway 3510, Camlab, UK). Probe of pH and temperature was dipped into a 50 mL sample for 2 min (for stable reading). Recorded data were means of triplicate values. The alcohol content of wine was estimated as per Caputi *et al*. (1968).

Specific Gravity

Specific gravity (SG) of different wine versions was determined by using hydrometer. 50 mL of the sample was taken into a measuring cylinder at 20°C; and a hydrometer was dipped into it to determine the specific gravity with appropriate temperature correction factor. The percentage alcohol content, calories, residual sugar (RS), apparent fermentation degree (AFD), fermentative capacity (VC), fermentation velocity (FV), and attenuation were then calculated based on specific gravity chart (American Society for Brewing Chemists, May and Shape (2004); Delfini and Formica (2001).

$$\text{Percent alcohol by volume} = \%ABV = \frac{initial\ SG - Final\ SG}{7.37} \times 1000$$

$$\text{Residual sugar} = \text{brix} = RS\ (\%) = 231.3\left(1 - \frac{1}{Final\ SG}\right)$$

$$\text{Apparent attenuation} = App.\ Attn\ (\%) = \frac{initial\ SG - Final\ SG}{Initial\ SG - 1} \times 100$$

$$\text{Apparent fermentation degree} = AFD\ (\%) = \frac{initial\ SG - Final\ SG}{Initial\ SG} \times 100$$

$$\text{Fermentative capacity} = VC\ (\%) = \text{Initial RS-Final RS}$$

$$\text{Fermentation velocity} = FV = \frac{Alco\square olic\ content\ (\%)}{Initial\ RS(\%) - Final\ RS\ (\%)} \times 100 = \frac{Alco\square olic\ content\ (\%)}{Fermentative\ capacity}$$

Racking, Pasteurization and bottling

The clear wine was siphoned off from the lees in steel pots using sterilized polythene pipes and covered with metal dish and pasteurized by heating to 70^0C for 15 minutes and cooled to room temperature (30^0C) by cooling in tap water. No chemical was added for the clarification of ginger honey wine. Cold wines were racked and filled into pre-sterilized bottles and kept in room until needed for further analysis.

Sensory Evaluation

A total of 10 assessors of govt college, Hisar was selected to assess the wines using a nine-point hedonic scale. Each evaluator was served with approximately 50 ml of wine sample with 250 mL wine tasting glasses. Results were ranked and expressed in accordance with the sensory vocabulary. The quality of analyzed wine was analyzed by sensory analysis (Smell, taste, mouth feel, color and overall acceptance).

Microbial Analysis

Microflora of different wine versions was determined using PDA for yeast, Nutrient Agar for bacteria and relevant biochemical assays (Cowan and Steel, 2004). 1 ml of wine sample was taken with the help of sterilized pipette and diluted by serial dilution technique. One ml of the appropriate dilution was transferred with the help of a sterilized pipette in sterilized petriplates in triplicates. About 10–15 ml of the media at 40^oC was then poured, and allowed to set at room temperature for an hour. The plates were incubated in a BOD incubator at 30^oC for 48 h, in inverted position the colonies were counted for each dilution and plates contains 100-200 colonies were used for enumeration as per standard method.

Statistical analysis

The data was tabulated and subjected to analysis of variance (ANOVA) according to factorial completely randomized design. The Critical Difference Value at 5% level was used for making comparisons among different treatments.

RESULTS & DISCUSSION

The experimental results emanating from the present study are presented in this paper. The study was focused on the objective to explore the production of Zinger honey wine. Production of wine from ginger and honey conducted in the lab in batch reactor set up. Process monitoring and final analysis of wine has been conducted. Table 2 shows the nutritional and physicochemical qualities of raw materials before fermentation to various wine versions.

TABLE 2. Nutritional and physicochemical qualities of honey and ginger (Before fermentation)

Parameter	Raw Honey	Ginger extract
Sugar content(g/l)	68.74	1.7
Moisture content (%)	16.7	81.3
Ash (%)	0.35	3.5
Crude Fat content (%)	ND	0.90
pH	4.05	5.6

The ginger honey wine was prepared from the mashes of different composition of zinger and honey with varying concentration of sugar. As the natural sugar content of most of the fruit juices/pulp is lesser than optimum level required for wine making, amelioration of juice with sucrose is a common practice. Shukla and Revis (1985) found that the T.S.S. of musts should be maintained at 23^oBrix for preparation of citrus wines. Lingappa and Naik (1997) have reported much lower T.S.S. (18^oBrix) for fermentation of carrot juice. In next experiment, prepared mashes were inoculated with baker's yeast at the rate of 1g/litre. An optimum inoculum level in the range of 4-6% for wine production has been reported by Prescott and Dunn (1949). Sterehaina *et al.* (1983) reported decrease in fermentation time with increase in inoculum level. An inoculum concentration of 10.0% (v/v) has been found to be appropriate by these workers for industrial fermentation which reduced the chance of contamination of fermentation media. pH and acidity of prepared mashes were also maintained because acids are helpful in reducing the contamination of fermentation media with undesirable micro flora. Wine preparation from less acidic fruits juices/pulp need to be acidified before fermentation. Bardiya *et al.* (1974) reported that acceptability of guava wine was more when the pH was adjusted to 3.5 before fermentation. Jackson and Badri (2003) adjusted pH to 3.0-3.5 with citric acid in case of banana wine. Finally these mashes were incubated for 11 days at constant

temperature (22°C) until constant TSS was obtained. Fermentation temperature is one of the most important factors in ethanol production as it exerts a profound effect on the growth and survival of yeast. Temperature has many other effects besides its direct effect on yeast activity and growth. Higher temperature results in loss of alcohol and aromatic constituents and the formation of higher alcohol along other by products (Jarczyk and Wzorek, 1977). Optimum temperature for alcoholic fermentation ranges between 20 and 28°C (Amerine *et al*., 1972). Time for completion of fermentation varies with fruit to fruit and other fermentation conditions. Under favourable conditions, musts usually complete fermentation within two to three weeks. Kainsa and Gupta (1979) reported that fermentation of ber juice completed in 8 days. After completion of the fermentation the wines were analyzed for chemical properties and sensory/non sensory evaluation. The final TSS of ginger honey wine made from the mashes having different initial TSS.

Determination of the physiochemical properties of ginger honey wine

Table 3 shows the physiochemical properties of ginger honey wine**.** Acetic acid content, off flavor and haziness in wines and other beverages can be measured in terms of volatile acidity. It acts as an indicator for sensory and microbial quality of different wines. In the present study, the level of volatile acidity was very low (0.37 to 1.3 g/L) across all the wine versions (Table 3). Volatile acidity of pear-honey, plum-honey, apple-honey and honey wines was recorded to be 0.3, 1.9, 0.5 and 0.25 per cent (v/v) respectively (Joshi *et al*., 1990a). It indicated the good quality of wine. The Quantity and sugar utilization rate measured by fermentative capacity and apparent fermentation degree, both of these parameters are correlated. Fermentation velocity measures the percentage or rate of sugar conversion to alcohol. It was observed that wine version BS5 had the best rate (0.088). But, these values were significantly low compared to literature data (Cordero *et al*., 2016). Only two factors, temperature (22^{0}C) and pH (3.5 -4) did not show any major variation among the assessed wines. Similar to this study, most previous studies (May *et al*., 2004; Umeh *et al*., 2015; Reddy *et al*., 2009) on fruits and vegetable wines reported acidic beverages of pH below 6.

TABLE 3: Enological properties of zinger honey wines produced with S. cerevisiae for 11 days

Mashes	Initial specific gravity	Final specific gravity	Alcohol by volume (%)	Apparent attenuation (%)	Calories (per 12oz bottles)	Residual Sugar (g/l)	Fermentative capacity	Fermentation velocity	Volatile acidity g/l	Total titrable acidity g/l
GH1	1.0830	1.0098	11.6	88	270.8	25	175	0.066	1.35	16.6
GH2	1.0830	1.0277	10.6	66	279.4	70	130	0.081	0.98	12.9
GH3	1.0830	1.0237	11.1	71	277.5	60	140	0.079	1.20	14.5
GH4	1.0830	1.0058	13.2	94	268.9	15	185	0.071	1.42	16.5
GH5	1.0830	1.0237	11.8	66	279.4	60	140	0.084	1.01	13.1
GH6	1.0830	1.0277	11.0	66	279.4	70	130	0.084	1.25	14.7
GH7	1.0830	1.0058	11.9	94	268.9	15	185	0.064	1.31	16.4
GH8	1.0830	1.0197	12.6	76	275.6	50	150	0.084	0.92	13.2
GH9	1.0830	1.0177	11.8	78	274.6	45	155	0.076	1.21	14.1
BS1	1.0741	1.0177	10.9	76	245.2	0	150	0.072	0.37	12.5
BS2	1.0920	1.0359	10.9	60	312.8	45	135	0.080	0.35	12.3
BS3	1.1011	1.0463	10.6	52	347.6	90	130	0.081	0.37	12.8
BS4	1.1103	1.0568	11.4	47	382.0	115	125	0.091	0.31	11.6
BS5	1.0654	1.000	10.6	100	0.0	140	120	0.088	0.37	12.3

Percent sugar conversion rate is measured by apparent attenuation. It was highest in blend BS5 (100) and followed by blend GH4 and blend GH1. After fermentation, the final specific gravity was decreased in all fourteen blends of wines. The maximum alcohol content was found in blend GH4 which was then followed by blend GH82 and blend GH7. The range of alcoholic contents observed in this study were within the limits (6-14%) reported in previous study (Kundu *et al*., 1976; Kim *et al*., 1987). Titratable acidity is used as a guide to determine how acidic the product will taste. This determination measures the concentration of all available hydrogen ions present in the sample, wine or juice. Normally it ranges from 5g/l to 6.5g/l. in present study, titrable acidity come out in suggested range. Ghadge *et al*. (2006) observed that titrable acidity content of grape wine sample ranged between 0.66-0.71percent. Chowdhury and Ray (2007) prepared wine from jamun and observed that the titrable acidity increased from 0.51 in must to 1.11 in finished wine.

Clarification of ginger honey wine

After two or three racking over a period of approximately one month, zinger wine became quite clear, there was no sign of turbidity or unwanted suspended particle. Natural clarification was achieved by sedimentation of yeast cells and there were no impurities. Adding bentonite alters the natural color and flavor of wine, so there was no need of adding bentonite in the ginger honey wine.

Sensory evaluation

Sensory evaluation was done by semi trend panelists including students, teachers and staff of govt college Hisar. The data selected for sensory evaluation was smell, taste, color, mouth feel and overall acceptance. Table 3 shows the sensory data of ginger honey wine prepared from different composition.

TABLE 3: Sensory data (According to 9 point hedonic scale) and non sensory data

	Sensory data				
Mashes	Aroma	Taste	Mouth feel	Color and appearance	Overall acceptability
GH1	9	9	9	9	9
GH2	6	7	7	8	7
GH3	6	7	7	8	7
GH4	9	9	9	9	9
GH5	8	6	6	8	7
GH6	7	7	6	8	7
GH7	9	9	9	9	9
GH8	8	6	6	8	7
GH9	6	6	6	6	6
BS1	8	8	8	8	8
BS2	9	7	7	9	8
BS3	8	8	8	8	8
BS4	8	8	8	8	8
BS5	7	7	7	7	7

TABLE 4: Table showing non sensory data

	Non Sensory data					
Mashes	Color	Relative Sweetness	Alcohol content	Effervescence	Acidity/Alkalinity	Calories
GH1	Light Straw	Sweet	Natural	Still	Acidic	High
GH2	White	Sweet	Natural	Still	Acidic	High
GH3	Pale Yellow	Sweet	Natural	Still	Acidic	High
GH4	Straw	Sweet	Natural	Still	Acidic	High
GH5	White	Sweet	Natural	Still	Acidic	High
GH6	Pale yellow	Sweet	Natural	Still	Acidic	High
GH7	Dark straw	Sweet	Natural	Still	Acidic	High
GH8	White	Sweet	Natural	Still	Acidic	High
GH9	Pale yellow	Sweet	Natural	Still	Acidic	High
BS1	Light pink	Sweet	Natural	Still	Acidic	High
BS2	Light pink	Sweet	Natural	Still	Acidic	High
BS3	Light pink	Sweet	Natural	Still	Acidic	High
BS4	Light pink	Sweet	Natural	Still	Acidic	High
BS5	Light pink	Dry	Natural	Still	Acidic	Low

CONCLUSION

As we know, Excess production of ginger during the winter seasons is wasted due to low market price and storage problems. The present study indicates that the ginger can be converted into value added product through fermentation. Its medicinal properties can be increased by making blend with honey. Honey ginger wine versions have relatively low alcohol content than the commercially available wines, so these wines are not harmful for health and are acceptable for daily usage. In fact, it has many health benefits. These wines are acidic, sweet to dry and low to high alcoholic. This study proves that acceptable wine can be prepared from ginger honey mix. The results of process monitoring and final analysis will help a small scale wine industry or can refer the results to develop a small scale wine industry.

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