African Journal of Food Science and Technology (ISSN: 2141-5455) Vol. 3(9) pp. 227-235, November 2012
Available Online http://www.interesjournals.org/AJFST

Full Length Research Paper

Effect of improved preparation methods on physicochemical characteristics and consumer acceptability of honey wine (mead)

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Accepted 13 November, 2012

During the present trial Alcoholic content, residual O_2 andCO_2 level as well as overall organoleptic property (Acidity, sweetness, Astringency, body, flavor, aroma, color, appearance and general quality) of six type of honey wines differ in honey type used and process condition were studied. Alcoholic content showed significant ($p<0.05$) difference among the six honey wine types where the maximum alcoholic strength was obtained from improved and processed honey wine (12.95 $\pm$ 2.69 %).Whereas the lowest alcoholic strength was recorded from Uncontrolled and Unprocessed honey wine. In this study we found inconsistent value regarding residual O_2 level and there is no significant difference between honey wine types with respect residual CO_2 level. Panel test of overall organoleptic property showed significant ($p<0.05$) difference in all the aforementioned quality attributes except body where in majority of quality attributes values close to normal (1-3 scale) and excellent (1-5 scale) were given by panelists for honey wine produce under controlled and improved condition from processed honey as compared to honey wine prepared under uncontrolled condition from unprocessed honey.

Keywords: Processed honey, Unprocessed honey, Controlled condition, Improved condition, honey wine, Alcoholic strength, Panel test, Organoleptic properties

INTRODUCTION

Africa is blessed with numerous types of wild honeybee (Adjare, 1990). Ethiopia is one of the countries of the continent which own big honey production potential. Owing to its varied ecological and climatic conditions, Ethiopia is home to some of the most diverse flora and fauna in Africa. Its forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees (Girma, 1998).

Beekeeping is one of the oldest farming practices in the country. There is an ancient tradition for beekeeping in Ethiopia which stretches back into the millennia of the country's early history (Girma, 1988). Of all countries in the world probably no country has a longer tradition of beekeeping than Ethiopia (Hartmann 2004). Moreover, beekeeping is an appropriate and well-accepted farming technology and it is best suited to extensive range of ecosystems of tropical Africa. To date, over 10 million of bee colonies are existing, which include both feral, and hived ones (Ayalew, 2001).

Ethiopia is the largest honey producer in Africa and 10th largest honey producer all over the world (Girma, 1998). Ethiopia, having the highest number of bee colonies and surplus honey sources of flora, is the leading producer of honey and beeswax in Africa (Gidey and Mekonen, 2010).

The total honey production of Ethiopia is estimated up to 24000 metric tons; only a small amount of this is

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marketed (Hartmann 2004). However, the income obtained from this subsector is still low as compared to the potential of the country. Although thousands of tones of honey are produced every year it is usually poorly managed and unattractive in appearance. Because of this its place in the local market being taken by imported honey (Gidey and Mekonen, 2010).

Moreover, the volume of export in both honey and beeswax products has notably declined since the last decade. This is largely attributed to the deterioration in quality of the products, EU (European Union) restriction and increasing demand in the domestic market (Beyene and David, 2007).

Besides poor marketing conditions the main reason is that about 80% of the total Ethiopian honey production goes in to the local Tej-preparation, a honey wine, which consumed as national drink in large quantities (Hartmann 2004). However the honey wine have limited market place around the production area and characterized by poor quality and safety standards.

Thus production of a honey wine with better shelf life and known physico-chemical characteristics to increase consumer's confidence on the product can be a potential means of filling the market gap and increase the income earned from the sector.

However because of lack of scientific production procedure and the high ambient temperature the Ethiopian honey wine is known by its hazy or cloudy appearance after bottling, precipitate after bottling , rapidly perishablity , sourness and unknown alcoholic strength and physico-chemical charactertics.

Thus, in order to achieve high standards of quality and meet consumers demand for quality and safe honey wine, physico-chemical and microbiological examinations of honey wine should be done. Identification of the critical points for the possible causes of spoilage also need due consideration so as to design effective control measure to improve storability and quality of honey wine.

MATERIAL AND METHOD

Honey (both processed and unprocessed) and other ingredients used in the production of honey wine was purchased from the market. Physicochemical tests (Moisture content and Hydroxymethylfurfural (HMF)) which are most significant for honey wine production were measured by using the established analytical techniques for honey (International Honey Commission 2002).

Honey wine preparation

Honey wine of the following type was prepared from both processed and unprocessed honey: Processed and controlled parameters, Processed and uncontrolled parameters, Processed and improved, Un-Processed and uncontrolled parameters, Un-processed and controlled parameters and Un-Processed and improved.

Honey wine with controlled parameters

This honey wine was produced by using standard procedure/scientific method in the preparation of honey wine. First, the "must" was pasteurized to kill all wild yeast and some microbes prior to fermentation. Second, the fermentation is conducted by using bioreactor which can control every process steps and parameter. Process like pasteurization, oxygenation and agitation and parameters like temperature and pressure was controlled. This type of wine was prepared by using both processed and unprocessed honey .The products are named throughout this document "Controlled and processed "if the honey is processed and the aforementioned fermentation parameters are controlled during honey wine preparation. Whereas honey wine made from unprocessed honey but all the above parameters controlled are named "Controlled and Unprocessed"

Honey wine with improved parameter controls

The improved honey wine was produced by using scientific procedures and methods. The difference between the improved and the aforementioned type of hone wine is that the methodology applied here can be easily applicable for individuals or cooperatives who want to produce honey wine. For instance, to make the fermentation anaerobic an airlock (which can allow CO_2 to live from the fermented and to protect the entrance of O_2) was used. Secondly among different fining agents egg white is selected and used because it is easily applicable. Thirdly, to get the benefits of agitation, the fermentation vessel was shaken each day. Similarly, honey wine from unprocessed honey by this method named as "Unprocessed and improved" .Where as honey wine produced by this method from processed honey named "Processed and improved"

Honey wine with uncontrolled parameters

This group of honey wine was produced by using procedures and methods that are used in traditional preparation of 'tej'. This honey wine was used as a control to check the improved and controlled honey wine groups. Honey wine from unprocessed honey produced by this method was named "Uncontrolled and unprocessed .Whereas honey wine produced from processed honey by this method named "Uncontrolled and processed'.

Table 1. Effect of processing on HMF and Moisture content of honey

Honey type	Hydroxymethylfurfural (HMF) (mg/kg)	Moisture content (%)
Un processed honey	81.460±7.646[a]	16.200[a]
Processed honey	32.770±7.646[b]	13.500[a]
p-value	0.046	0.057

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences.
*Values show mean (n=3) and standard error of the mean

Table 2. Effect of different honey wine preparation methods on brix and PH value of the honey wine must

Honey wine preparation method	Must °brix	P^H
Controlled+ processed	22.420 ± 0.052a	3.46 ± 0.008[a]
Controlled+ unprocessed	21.450 ± 0.052b	3.41 ± 0.008[b]
Improved+ processed	22.295 ± 0.052a	3.40 ± 0.008[b]
Improved+ unprocessed	21.450 ± 0.052b	3.40 ± 0.008[b]
Uncontrolled + un processed	21.450± 0.052b	3.47 ± 0.008[a]
Uncontrolled +processed	21.900 ± 0.052c	3.5 ± 0.008[c]
P-value	0.000	0.000

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences.
*Values show mean (n=3) and standard error of the mean

Physico-chemical and microbiological analysis of end product (honey wine)

After honey wine was produced, to check the quality of the honey wine, physico-Chemical analysis such as Alcoholic strength (percent), dissolved CO_2 andO_2 level and P^H as well as plate count was done by using standard methods in food analysis. Consumer's perception of the product (Total organoleptic properties: Aroma, flavor, taste, clarity, and color) was assessed by a widely employed method of perception/preference score**.** The uncontrolled and controlled honey wine was used as a control for improved honey wine and international standards for alcoholic beverages are used as a reference.

Data handling and statistical analysis

Alcohol content, residual CO_2 level, residual O_2 level obtained from instrumental analysis, as well as colony number from plate count and perceptions score given by the panelists for each organoleptic properties and corresponding treatments were recorded and mean values were calculated.

Summary statistics (mean and standard deviation) was computed for each dependent variable in order to find differences between treatments. Data obtained from panel test, physicochemical as well as microbiological analysis was all submitted to General Linear Model (GLM) procedure from SPSS 15.0 (SPSS, 2006) statistical software package to determine the best raw material and production condition combination for the production of honey wines of superior organoleptic and physicochemical property. The treatments whenever found significant, the tukey test was used for pair wise comparisons among the different treatments at the 5% ($p < 0.05$) significant level.

RESULTS AND DISCUSSION

Effect of processing on moisture content and hmf of honey

Mean HMF and moisture content and standard error of the mean (SEM) of the two honey types (processed and unprocessed) are given in Table 1.

Statistical treatment of the analytical data showed significant ($P< 0.05$) difference of processing on HMF values. An HMF value from unprocessed honey was significantly higher than HMF value from processed honey. The probable reason for this difference in HMF value may be prolonged storage time and storage temperature, however these two conditions of the honey samples is not known.

There was no significant difference between the two honey types with respect to moisture content (Table 1).

Table 3. Effect of different honey wine preparation methods on Alcoholic content andPH value of the honey wine

Honey wine preparation method	Alcoholic content (%)	P^H
Controlled+ processed	12.37 ± 2.69[a]	3.34 ± 0.26a
Controlled+ unprocessed	11.18 ± 2.69[b]	3.36 ± 0.26a
Improved+ processed	12.95 ± 2.69[a]	3.34 ± 0.26a
Improved+ unprocessed	12.42 ± 2.69[a]	3.35 ± 0.26a
Uncontrolled + un processed	9.75± 2.69[c]	3.04 ± 0.26b
Uncontrolled +processed	10.80± 2.69[b]	3.38 ± 0.26a
P-value	0.001	0.001

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences.
*Values show mean (n=3) and standard error of the mean

Even though the difference was not significant the moisture content decreased as the honey processed .This decrement may be due to the higher temperature creating during honey processing.

Effect of honey type on ^{0}brix and p^h value of honey wine must

The effect of honey type (processed vs. unprocessed) on °brix and P^H of honey wine must is summarized below (Table 2).

The two groups of "must" made from different honey types showed statistically significant ($p<0.05$) differences with respect degree brix. Where must prepared from processed honey revealed the highest degree brix and magnify the effect of processing in reducing the moisture content and concentrate the honey. The probable reason for lower degree brix value of must from unprocessed honey may be the presence of some impurities such as bee part, wax, and other impurities in the case of unprocessed honey type that will lead to a decrease in ^{0}brix. The other reason for the difference in degree brix between the two groups of musts may be the difference in sources of the honey and composition of the honey where there is luck of information regarding these sources of variation.

The two must groups differ in the honey type used showed no significant ($p>0.05$) difference in P^H value (Table 2). Even though the difference is not statistically significant, the lower P^H was recorded from unprocessed honey where there is a high chance of to be stored for long time and probability of fermentation is high which in turn will lead to an increase in acidity (Table 2).

Effect of different honey wine preparation methods on alcohol content and ph value of honey wine

The six honey wine preparation methods tested in the present study showed significant ($p<0.05$) difference with regard to alcoholic strength of the honey wine. The mean alcoholic content and P^H of the studied preparation methods are summarized in Table 3.

In the present study honey wine prepared under condition where all the necessary fermentation parameters controlled or improved showed higher alcoholic content as compared to honey wine prepared in uncontrolled condition. Even though it is not significant, pair wise comparisons in Table 3 revealed higher alcoholic content of honey wine prepared by improved methods as compared to honey wine prepared by controlled method. However under the same controlled condition unprocessed honey showed significant ($p<0.005$) difference with processed honey. Even under the same uncontrolled condition the two honey types showed significant difference in terms of alcoholic content where the higher alcoholic strength was recorded from honey wine prepared from processed honey. This difference of processed and unprocessed honey may be a reflection of the effect of degree brix difference on alcoholic content of honey wine as brix value of must prepared from processed honey was higher than un-processed honey (Table 2).

The major reason for the significant difference between controlled and processed with controlled and unprocessed (Table 3) may be due to the difference in honey type which will determine the degree brix and hence the alcohol content of the honey wine. Whereas the reason for the significant difference between controlled and processed with uncontrolled and unprocessed may be the difference in honey type ,the effect of controlling the fermentation (which means the more the fermentation is controlled the shorter the time to produce alcohol) and the effect of using standard wine yeast in the case of controlled.

Similarly, the reason for the significant difference between controlled and processed and uncontrolled and processed may rise from the effect of controlling the fermentation and using wine yeast in the case of controlled and processed honey wine.

The other significant difference was observed between controlled and unprocessed and improved and processed. The possible reason for this can be the

Table 4. Effect of different honey wine preparation methods on dissolved CO2 andO2 level of honey wine

Honey wine preparation method	Dissolved O_2 (g/lt)	Dissolved CO_2 (g/lt)
Controlled+ processed	1.83 ± 0.058[a]	1.16 ± 0.042[a]
Controlled+ unprocessed	3.02 ± 0.058b	1.18 ± 0.042[a]
Improved+ processed	3.50 ± 0.058c	1.12 ± 0.042[a]
Improved+ unprocessed	2.34 ± 0.058d	1.17 ± 0.042[a]
Uncontrolled + un processed	2.00± 0.058a	1.20 ± 0.042[a]
Uncontrolled +processed	2.71 ± 0.058e	1.22 ± 0.042[a]
P-value	0.000	0.656

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences.
*Values show mean (n=3) and standard error of the mean

difference in honey type as wells as the effect of agitation and aeration at the beginning of fermentation in the case of controlled and unprocessed honey wine. Aeration of a must before the beginning of fermentation allow the yeast to produce sterols and unsaturated fatty acid which are a pre requisite for a yeast cell to grow under anaerobic condition and this improve the capacity of the yeast to ferment the available fermentable sugar in turn increase the alcohol content produced.

The reason for the significant difference between controlled and uncontrolled preparation method from unprocessed honey may be also due to the effect of controlling the fermentation and using wine yeast in the case of controlled preparation method.

There was also as significant difference in terms of alcoholic content between honey wine prepared under improved condition and uncontrolled condition . similarly this result can be justified from the effect of controlling fermentation parameters and using standard wine yeast in case of improved honey wine preparation methods .

Statistical treatment of the analytical data showed also significant ($P< 0.05$) difference of honey wine preparation methods on P^H values of honey wine (Table 3).

Among the treatments the lower P^H value was observed from honey wine prepared under uncontrolled condition from unprocessed honey where this P^H value was significantly different from all preparation methods even with honey wine prepared from processed honey but under uncontrolled condition. The possible reason for this lower P^H value from unprocessed honey under uncontrolled condition may be the difference in the type of honey (Unprocessed honey may create favorable condition for the acid producing yeast/bacteria). Since the fermentation is wild in case of uncontrolled preparation method there may be a possibility for acid producing yeast/bacteria to involve in the fermentation

Effect of different honey wine preparation methods on dissolved CO_2 and O_2 level of honey wine

Honey wine preparation methods tested in the present study showed significant ($p<0.05$) difference with regard to residual O_2 level of the end product. However there is no significant ($p>0.05$) difference among the six preparation methods with regard to residual CO_2 level of the end product. The mean residual O_2 and residual CO_2 level and P-value of the studied preparation methods are summarized in Table 4. The effect of T° during O_2 measurement may be the reason for this inconsistent result of residual O_2 level.

Effect of different honey wine preparation methods on panel preference score of honey wine quality attributes rated by 1-3 scale

Mean panel preference score (1-3 scale) of acidity, sweetness, astringency and body of honey wine produced by the six honey wine preparation methods are given in Table 5.

Effect of different honey wine preparation methods on acidity of honey wine

The six preparation method showed significant ($p<0.05$) differences in terms of acidity of the honey wine. Among the six different types of honey wine produced the controlled and processed type of honey wine is get the lowest acidity value by the panelists and is significantly different from all preparation methods except honey wine produced improved condition from processed honey and controlled condition and unprocessed honey. Whereas honey wine produced under uncontrolled condition and unprocessed honey gets the highest acidity value and is significantly different from all preparation methods except honey wine produced from processed honey under uncontrolled condition (Table 5). The possible reason for this can be the difference in honey type where the highest acidity value was given for honey wine prepared from unprocessed honey. The other reason may be the effect of pasteurization in the case of controlled honey wine that minimize the effect of acid producing and yeast

Table 5. Mean panel preference score (1-3 scale) of acidity, sweetness, astringency and body of honey wine produced by the six honey wine preparation methods

Honey wine preparation method	Acidity (1-3 scale)	Sweetness (1-3 scale)	Astringecy (1-3 scale)	Body (1-3 scale)
Controlled + unprocessed	1.77^{a}	1.77^{afg}	1.70^{a}	1.6^{a}
Improved + processed	1.67^{a}	1.67^{badf}	1.73^{a}	1.7^{ab}
Uncontrolled + un processed	2.73^{b}	1.50^{cadf}	2.23^{b}	2.17^{b}
Improved + unprocessed (	2.23^{c}	1.30^{daf}	2.30^{b}	1.87^{ab}
Controlled + processed	1.53^{a}	2.20^{eg}	1.50^{a}	1.73^{ab}
Uncontrolled + processed	2.47^{bc}	1.48^{f}	2.41^{b}	1.86^{ab}
P-value	0.002	0.033	0.004	0.223
SEM	0.120	0.136	0.106	0.142

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences. Values are shown as means ($n = 6$).
SEM= Standard error of the mean

and bacteria's. The probable reasons for low acidity value for honey wine produced under controlled condition are:

- ✓ The effect of aging in the case of controlled honey wine because ageing under controlled condition is short and this reduce the chance of increasing acidity of honey wine.
- ✓ The effect of fermentation since under controlled condition the yeast used is with known characteristics with less probability of producing acids that give the wine undesirable acidic taste.
- ✓ The entrance of oxygen while opening the fermentation vessel in the case of uncontrolled condition may not favor the occurrence of anaerobic condition which is required for alcohol synthesis and this may favor the production of other alcohols and acids.

Effect of different honey wine preparation methods on sweetness of honey wine

The six preparation method showed significant ($p<0.05$) differences in terms of sweetness of the honey wine. Among the six different types of honey wine produced under improved condition from unprocessed type of honey wine gets the lowest preference score which is close to normal. Whereas honey wine produced from processed honey and controlled and processed is the highest sweetness value which is close to extreme sweetness according to the questionnaire provided for panelists in sweetness. The possible reason for this can be the differences in the type of honey in turn the difference in the residual sugar content between the two honey wine types. If the residual sugar content is very high then the sweetness does too thus the result agree with this assumption as sugar content as evident from high brix value was higher for processed honey so that some of the sugar may left unfermented and contribute for sweetness to the undesirable side.

Effect of different honey wine preparation methods on astringency of honey wine

The six preparation method showed significant ($p<0.05$) difference in terms of astringency of the honey wine (Table 5). Among the six different types of honey wine produced the honey wine produced under controlled condition from processed type of honey gets the lowest astringency value which is closed to the normal choice given in the questionnaire used for panel test .Whereas honey wine prepared under uncontrolled condition and made from processed honey show the highest astringent value which is close to the extreme astringency value given in the questionnaire. This rank of astringency is in agreement with the rank given for acidity as astringency is expressed as sharp in acidic character (Table5).The possible reason for this can be explained by the effect of

some treatments in the case of controlled honey wine. For instance, the addition of a known strain of wine yeast and use of processed honey free from impurities may have a positive impact on acceptable astringency value of controlled and processed honey wine. On the other hand the entrance of oxygen while opening the fermentation vessel in the case of uncontrolled honey wine will lead to the production of some compounds which have an unacceptable astringent perception by consumers.

Effect of different honey wine preparation methods on body of honey wine

The six preparation method showed no significant ($p>0.05$) differences between honey wine preparation in terms of body perception of the honey wine. Even though the difference is not significant among the six different preparation methods , honey wine produced under controlled condition from unprocessed honey get the lowest preference score Whereas honey wine made under uncontrolled condition and from processed honey receive highest body preference score from panelists . However, from the inconsistent values given for this organoleptic property by panelists as well as the frequently raised ambiguity about this parameter, this study found this organoleptic property least understood by the panelists. As a result it is difficult to use this quality attribute as a means of comparing the different honey wine preparation method.

Effect of different honey wine preparation methods on panel preference score of honey wine quality attributes rated by 1-5 scale

Mean panel preference score (1-5 scale) of appearance, flavor, color and general quality of honey wine produced by the six honey wine preparation methods are given in Table 6.

Effect of different honey wine preparation methods on appearance of honey wine

The six preparation method showed significant ($p<0.05$) difference in terms of appearance of the honey wine (Table 6). Among the six different types honey wine produced under controlled condition from processed type of honey controlled receive higher preference score close to excellent appearance value. This honey wine (controlled and processed) was also significantly different from all honey types except honey wine prepared under improved condition from unprocessed honey .Whereas the least appearance value close to satisfactory range was given to honey wine prepared under uncontrolled condition from processed honey (Table 6). The possible reason for this difference can be justified from the effect of treatments like racking, fining, stabilizing, and aging practiced during controlled honey wine preparation, as all this factors contribute positively on the appearance of the controlled honey wine by allowing settling of impurities and haze precursors that affect the appearance of honey wine .The other probable reason for superior appearance of honey wine from controlled condition may be also the effect of pasteurization in the case of controlled honey wine that may allow formation of “hot breaks” and settling of proteins and other haze precursors.

Effect of different honey wine preparation methods on Flavor of honey wine

The six preparation method showed significant ($p<0.05$) difference in terms of flavor of the honey wine (Table 6). Among the six different types honey wine produced under improved condition from processed honey, controlled condition from processed honey and controlled condition from unprocessed honey receive the highest flavor preference score close to excellent value (Appendix 2). in decreasing order. However there is no significant ($p<0.005$) among these honey wine types of superior quality. On the other hand the least flavor preference score was given to honey wine made under uncontrolled condition from unprocessed honey. This favor preference score given for this honey wine is significantly ($p< 0.005$) different from all honey wine types except honey produced under uncontrolled condition from processed honey (Table 6). The possible reason for these differences may rise from the difference in honey type where the two lower flavor preference scores were given for honey wine produced from unprocessed honey that may affect the flavor of honey wine because it contains, wax, bee matter, pollen and other impurities. Whereas the superior flavor preference score given for honey wine produced under controlled and improved conditions can be justified from the effect of fermentation condition in the case of improved and controlled honey wine. For instance, the addition of wine yeast will have a positive impact on the flavor of the improved honey wine. In addition the short ageing time in case of controlled and improved condition may avoid the development of undesirable flavor due to prolonged ageing.

Effect of different honey wine preparation methods on color of honey wine

The six preparation method showed significant ($p<0.05$) difference in terms of color of the honey wine (Table 6). Among the six different types of honey wine produced under controlled condition from processed type of honey received highest color preference score followed by

Table 6. Mean panel preference score (1-3 scale) of appearance, Flavor, color and general quality of honey wine produced by the six honey wine preparation methods

Honey wine preparation method	Appearance (1-5 scale)	Flavor (1-5 scale)	Color (1-5 scale)	General quality (1-5 scale)
Controlled + unprocessed	3.23[a]	3.30[e]	3.00[a]	3.07[a]
Improved + processed	3.80[d]	3.60[e]	4.00[b]	3.63[b]
Uncontrolled + un processed	2.77[c]	2.03[fd]	2.93[a]	2.00[c]
Improved + unprocessed	3.97 [deb]	2.08[dg]	4.07[b]	1.77[c]
Controlled + processed	4.23 [b]	3.47[ec]	4.10[b]	3.57[bd]
Uncontrolled + processed	2.10[g]	2.10[bd]	2.10[c]	1.93[c]
P-value	0.000	0.001	0.003	0.000
SEM	0.110	0.153	0.210	0.121

Means followed by a different superscripts within columns show statistically significant ($p<0.05$) differences.
Values are shown as means (n = 6).
SEM= Standard error of the mean

honey wine produce under improved condition from processed and unprocessed honey respectively. There is no significant (<0.005) difference between the three honey wine groups that receive highest preference score close to excellent value (Appendix 2). On the other hand the least color preference score was given for honey wine produced under uncontrolled condition (Table 6).The possible reason for this color superiority of honey wine from improved and controlled condition can be justified from the effect of treatments like racking, fining, stabilizing, and aging in the case of honey wine produced under controlled and improved conditions.

Effect of different honey wine preparation methods on general quality of honey wine

The six preparation method showed significant ($p<0.05$) difference in terms of general quality of the honey wine (Table 6). Among the six different types honey wine produced under improved and controlled condition from processed honey receive highest general quality value from panelists with no significant ($p>0.005$) difference between them. Whereas honey wine produced under uncontrolled condition from both processed and unprocessed honey received least general quality preference score value with no significant ($p>0.005$) difference between them. The other honey wine received least general quality preference score value was honey wine produced under improved condition but from unprocessed honey that may signify the effect of honey type on general quality of honey wine.

Microbiological quality of honey wine types

Among the six different types of honey wine produced uncontrolled and unprocessed honey wine has the maximum number of colonies and controlled and processed has the minimum number of colonies. The possible reason for this is due to treatments like pasteurization, clarification, and stabilization in the case of controlled and processed honey wine. There is no significant difference between the improved and the controlled honey wines .the reason for this is that both types of honey wine pass almost the same treatments.

Identified critical points

In general from the microbiological, physicochemical, and sensory analysis of the end product the present study identifies the following process in honey wine production as critical points.

- Raw material selection (processed honey vs. unprocessed)
- Pasteurization of must
- Fermentation (aerobic vs. anaerobic, temperature,

agitation, andoxygenation)
- Yeast (wild vs. wine yeast)
- Pasteurization of end product

CONCLUSION AND RECOMMENDATION

In this study we confirmed that, the production of a good quality honey involves understanding and considering the following things. First, the type of honey for honey wine preparation must be selected properly. We have produce honey wine form both processed and unprocessed honey and on the basis of the physicochemical, microbiological, and sensory analysis we confirmed that that the honey wine produced from processed honey is better than the unprocessed type in terms of color, clarity, flavor, acidity, and general quality. Thus, this study recommends the use of processed honey to produce a good quality honey wine. Second, identification of the most significant unit operation in the production of a good quality honey wine must be conducted properly. In this study we confirmed that unit operations such as pasteurization of must and the honey wine, fermentation, clarification, stabilization and aging have great impact on the final product quality.

In the present study we produced a honey wine by pasteurizing the must and without pasteurizing the must. According to the physicochemical, microbiological, and sensory analysis we confirmed that a honey wine which is involves pasteurization of the must is better than the wine which is not pasteurized in terms of color, clarity, and general quality. Therefore, we recommend for a good honey wine production pasteurization of the must.

We have produced a honey wine by pasteurizing the wine and without pasteurizing the wine. After the physicochemical, microbiological, and sensory analysis we confirmed that a honey wine which is involves pasteurization is better than the wine which is not pasteurized in terms of color, clarity, flavor, and general quality. Therefore, we recommend for a good honey wine production pasteurization of the honey wine.

The honey wines produced in this study have conducted at different fermentation conditions. For instances, in the case of uncontrolled honey wine the fermentation is wild fermentation and in the other two types of honey wines(improved andcontrolled) the fermentation is conducted by adding a known strain of wine yeast. From the two fermentation types we have seen that the honey wine which is produced by wild fermentation is the least in terms of color, clarity, flavor, acidity, and general quality. Thus, we recommend that to produce a good quality honey wine wild fermentation must be avoided and the use of yeast strain of known characteristics is recommended.

Among the six types of honey wine produced in this project the fermentation for the four types of honey wine was conducted under anaerobic condition and for the remaining two the fermentation was aerobic. Form these types of honey wines; we confirmed that the wine which is produced under aerobic condition is the least in terms of color, clarity, flavor, acidity, and general quality. Thus, we recommend that for the production of a good quality honey wine the fermentation must be conducted under anaerobic condition.

In present study the temperature was controlled for improved and controlled types of honey wine, but not for uncontrolled honey wine. On the basis the physicochemical, microbiological, and sensory analysis we confirmed that the uncontrolled honey wine is least in terms of general quality. Therefore, we recommend that for the production of a good quality honey wine controlling the fermentation temperature.

In the case of controlled honey agitation was conducted and in the other two types of honey (improved and unprocessed) there was no agitation. From this we confirmed that controlled honey wine is best in terms of color, sweetens and alcohol content. Thus, we recommend the application of agitation while the fermentation is conducted for the production of a good quality honey wine.

The improved and controlled honey wines produced in this project have passed treatments like clarification, stabilization, aging but not the uncontrolled honey wine. Form this we confirmed that the uncontrolled honey wine is the least in terms of color, clarity, flavor, acidity, and general quality. Thus, we recommend that it is a must to use the aforementioned treatments for the production of a good quality honey wine.

In this study our objective was to produce an improved honey wine by using the other two types of honey wines (controlled and uncontrolled) as a control. Finally, we have produced an improved honey wine by employing locally applicable technology.

REFERENCES

Ayalew K (2001). Promotion of beekeeping in the rural sector of Ethiopia. In: Proceeding of the 3rd Ethiopian Beekeepers Association (EBA):52-58.

Beyene T, David P (2007). Ensuring small scale producers in Ethiopia to achieve sustainable and fair access to honey markets. Paper prepared for international development enterprises (IDE) and Ethiopian society for appropriate technology (ESAT), Addis Ababa, Ethiopia.

Gidey Y, Mekonen T (2010). Participatory Technology and Constraints Assessment to Improve the Livelihood of Beekeepers in Tigray Region, northern Ethiopia. MEJS, 2 (1):76-92. International Honey Commission (2002).

Girma D (1998). Non-Wood Forest Production in Ethiopia. Addis Ababa,Ethiopia. Retrieved from: http://www.fao.org/DOCREP/003/X6690E/X6690E00.htm

Hartmanns I (2004). The management of resources and marginalization in beekeeping Societies of South West Ethiopia. Paper submitted to the conference: Bridge Scales and Epistemologies, Alexandria: 1.

SPSS (2006) SPSS for windows: Statistical software, version 15.0