



**Wolkite University**

*We strive for wisdom*

**College of Engineering and Technology**

## **Department of Food Process Engineering**

**Title: Effect of Processing Methods of Local and Foreign Hop on physico-chemical and Sensorial Quality of *Tej***

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## Declaration

We the undersigned, declare that this thesis research is our original work and has not been presented for a Degree in any other University, and that all sources of materials used for the thesis have been duly acknowledged.

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## Abstract

*Tej* is a traditional fermented alcoholic beverage consumed in Ethiopia. Raw materials used for *Tej* preparation are honey, water and the leaves of the *gesho* plant. The study was conducted to determine effect of processing methods and type of hops on sensorial quality of *tej*. Beyond sensorial quality assessment pH, SG, TA, TSS and Alc were analyzed for within group (immersed and boiled) and between groups (foreign and local hops). The result revealed that pH, SG, TA ,and Alcoholic contents have no significance difference between local and foreign *gesho* and used immersed and boil method. This imply no effect immersed and boil method and local and foreign type *gesho* .*Tej* low pH, SG,TA the lower pH it imply that more acidic property it has high amount of TSS it has good solubility with water. Our *Tej* local immersed has gotten a good result of sensory evaluation when it was tasted based on 9-hedonic scale and it is formulated SPSS analysis as well as good judge perception.

key word: Analysis, *Gesho*, Hops, Processing, , Sensorial, *Tej*

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## **Abbreviations and Acronyms**

ANOVA	Analysis Variance
ALC	Alcoholic Content
CSA	Central Static Authority
FB	Foreign boiled
FI	Foreign Immersed
LAB	Lactic Acid Bacteria
LB	Local Boiled
LI	Local Immersed
LSD	Least Significance Difference
SG	Specific Gravity
TA	Titration Acidity

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# Chapter One

## 1.1 Introduction

Ethiopia is one of the countries where a wide variety of traditional fermented beverages are prepared and consumed. The various traditional fermented beverages consumed in Ethiopia consists of high alcoholic beers such as *tella*; low alcoholic beers such as *keribo*, *buqri*, *shamita*, *borde*, wine such as *tej* made from honey and distilled spirits such as *katikala* or *areki* (Ashenafi, 2000). Indigenous Ethiopian fermented beverages include '*tej*' Vogel & Gobezie, (1983); Fite *et al.*, 1991), *tella* (Sahle Gashe, 1991), *borde* and *shamita* (Ashenafi Mehari, 1995); (Bacha *et al.*, 1998). Alcohol in traditional beverages serves as source of calories valuable to the calorie-deficient villager. The primitive beverages provide not only calories but also B vitamins due to residues of the substrates, the fermenting yeasts and other microorganisms (Steinkraus, 1983).

Fermented beverages produced from cereals are usually referred to as beers while those produced from fruits are classified as wines (Pederson, 1979). Fermentation of a variety of foods or blends of fruits, cereals, milk sap, honey molasses and/or other foods are also wines (Pederson, 1979). Honey wines are primitive types of wines that are not crystal clear products. Instead they are cloudy, effervescent containing residues of substrates and fermenting yeasts and other microorganisms (Steinkraus, 1983).

*Tej* is a home-processed, but also commercially available honey wine. It is a beverage mainly used for great feasts, such as weddings and the breaking of fasting. It is prepared from honey, water and leaves of *Gesho* (*Rhamnus prenoides*). Sometimes, widely for commercial purposes, mixture of honey and sugar could be used for its preparation. In cases where sugar is used as part of the substrate, natural food coloring is added so that the beverage attains a yellow color similar to that made from honey (Fite *et al* 1991). Some also add different concoctions secrete herbal ingredients to improve flavor or potency and to attract customers. Due to concoction, adulteration practices and possibly some other reasons, producers usually are not willing total about additives used and their composition (Bahiru B.,(2000).

Fermentation of *tej*, like other traditionally fermented alcoholic beverages, relies on the microorganisms present in the substrates, fermentation vats or equipment. As these fermentations are natural and thus uncontrolled, alcohol and fuel oils produced during the fermentation can be

hazardous to health if produced beyond acceptable levels. With the variable micro flora of such spontaneous fermentation, variability of the product is inevitable (Bahiru B., 2000). The ethanol content of *tej* is reported to range from 13.2% to 13.7% (Desta B, 1977), 7% to 14% (Vogel Gobezie, 1983).

*Gesho*, *Rhamnus prinoides* is a dense shrub or sometimes appears as small tree. It is spineless and evergreen. It is one of the two representative species with *Rhamnus staddo* of the family *Rhamnaceae* that are only found in Africa (Phillips, 1994). *Gesho* is commonly used for preparation of traditional alcoholic beverages, *tella* and *tej* in Ethiopia. The *Gesho* plant (*R. prinoides*), which is different from hop (*Humulus lupulus*) is widely cultivated in Ethiopia and is available dried in the local market (Haimanot, 2011). Leaves and stems are good sources of a healthy diet; and they are not exposure routes to some metal contaminations under the current existing situation (Nagari Alemayehu, 2013). The leaves and stems of this plant are used to impart the characteristic bitter flavor to domestically brewed beverages known as ‘*Tella*’ and ‘*Tej*’ and it is estimated that well over 5 million people consume these beverages daily (Berhanu Abegaz and Teshome Kebede, 1995).

## **1.2 Statement of Problem**

*Tej* is a widespread home industry of considerable social and economic importance and mostly produced for commercial purposes. Sugar by many as fermentable substrate and addition of various plant parts and, their processing to increase potency of '*tej*' would result in differences in physico-chemical and microbial properties of the final product. The main objective of this research was to determine the effect of processing methods of local and foreign hops on sensorial quality of *tej*. In tropical countries like Ethiopia, Hops has been imported from other temperate countries and this involves the expenditure of scarce foreign exchange. *Rhamnus prinoides* (Amharic, name: *Gesho*) is a cultivated indigenous shrub which is also known to occur far west as Cameroon and as far south as South Africa, and Ethiopia. It has a potential use as a commercial hopping agent in the special beer industry and Leaves of *Rhamnus prinoides* (*Rhamnaceae*) is reported potential yielding plant and reasonably good with higher color strength values reflecting in direct affinity to cotton (Abera Kechi *et al.*, 2013).

### **1.3. Objectives**

#### **1.3.1. General Objective**

- ❖ To determine the effect of processing methods of local and foreign hops on physico-chemical and sensory quality of *tej*

#### **1.3.2. Specific Objectives**

- ❖ To analyze the physico-chemical properties of *tej*
- ❖ To analyze the sensory quality of *tej*

### **1.4. Significance of Study**

At end of the research we have obtained a valid contribution to different research as a source was helped to determine characteristics of foreign and local hops among the different processing methods. Also it was helpful in identification of the application and preservative effects of the different methods of processing

## Chapter Two

### 2.0 Literature Review

Fermented alcoholic beverages around the world are consumed in different occasions. In nearly all areas of the world, some type of alcoholic beverages native to its region is prepared and consumed ( Banwert, 1983). Fermented beverages vary considerably in type. Fermented beverages produced from cereals usually referred to as beers while those produced from fruits are classified as wines (Pederson, 1979).Indigenous fermented alcoholic beverages from different parts of the world are described (Steinkraus, 1983). Among these information on the microbiology and biochemical properties of varieties of the indigenous African fermented alcoholic beverages is available. These include Egyptian bouza, Tanzanian wanzuki, gongo, Nigerian palm-wine, Kenyan muratna and uragela, and South African kaffir beer Ashenafi *al*, (2001). Indigenous Ethiopian fermented beverages include *tej* (Vogel and Gobezie 1983; Fite, *et al.* 1991; Bahiru B., 2000) *tella* (Sahle and Gashe, 1991), *borde* and *shamita* (Mogessie A. and Tetemke M., 1995; Bacha *et al.*,1999), *araki* (Desta B., 1977; Fite, *et al.*,1991). Traditionally fermented beverages in Ethiopia, the most popular alcoholic beverages are *tej* (honey wine), *tella* (a malt beverage like beer) and *areki* (distilled liquor). These drinks are widely served on festive occasions and at social gatherings. According to a census conducted in 1988, about 11,000 persons were then engaged in the trade of traditional beverages in Addis Ababa alone (Central Statistics Authority, 1988). This is about 32% of the population of the city engaged in internal trade.

### 2.1 *Tej*

*Tej* is a home-processed, but also commercially available honey wine. It is a beverage mainly used for great feasts, such as weddings and the breaking of fasting. It is prepared from honey, water and leaves of *Gesho*(*Rhamnus prenoides*).Sometimes, widely for commercial purposes, mixture of honey and sugar could be used for its preparation. In cases where sugar is used as part of the substrate, natural food coloring is added so that the beverage attains a yellow color similar to that made from honey (Fite *et al.*, 1991). Some also add different concoctions such as barks or roots of some plants or secrete herbal ingredients to improve flavor or potency and to attract customers. Due to concoction, adulteration practices and possibly some other reasons, producers usually are not willing to tell about additives used and their composition (Bahiru, 2000).

According to Vogel and Gobezie, (1983) during the preparation of *tej*, the fermentation pot is seasoned by smoking over smoldering *Rhamnus prenoides* stems and olive wood. One part of honey mixed with 2 to 5% (v/v) parts of water is placed in the pot, covered with a cloth for 2 to 3 days to ferment after which wax and top scum is removed. Some portion of the most is boiled with washed and peeled *Rhamnus prenoides* and put back to the fermenting must. The pot is covered and fermented continuously for another 5 days, in warmer weathers, or for 15-20 days, in colder cases. The mixture is stirred daily and finally filtered through cloth to remove sediment and *Rhamnus prenoides*.

Good quality *tej* yellow, sweet, effervescent and cloudy due to the content of yeasts. The flavor of *tej* depends upon the part of the country where the bees have collected the nectar and the climate (Vogel Gobezie, 1983). Fermentation of *tej*, like other traditionally fermented alcoholic beverages, relies on the microorganisms present in the substrates, fermentation vats or equipment. As these fermentations are natural and thus uncontrolled alcohol and fuel oils produced during the fermentation can be hazardous to health if produced beyond acceptable levels. With the variable micro flora of such spontaneous fermentation, variability of the product is inevitable (Bahiru B., 2000). *Tej* is made from a fermenting combination of honey, water and the leaves of the *gesho* plant. After a couple of weeks, the mix yields a moderately sweet and slightly spicy golden-hued beverage. Bitter undertones soften the initial sweetness of the *tej* and make for a nice session drink. The strength of *tej* varies by batch and can end up anywhere from 6-11%. The color of the liquid varies from bright yellow to a deeper gold reminiscent of a lion's mane.

## **2.2 Ingredients of *Tej***

### **2.2.1 *Gesho*, *Rhamnus Prinoides***

*Gesho* (*Rhamnus prenoides*) local hops, is available dried in the local market. The leaves *gesho* (*Rhamnus prenoides*) is dried again in the sun for about ½ hour and after that pounded. The leaves are separated from the stems, which need a longer time to dry. The ground *gesho* (*Rhamnus prenoides*) leaves are placed in a clay container with water and left to ferment for 2-3 days. *Gesho* (*Rhamnus prenoides*) is responsible for the bitter taste of *tej* and the bitterness of *tella* is directly related to the amount of *gesho* added during brewing. It is also thought to be the source of various chemicals (Shale and Gashe, 1991).

*Gesho*, *Rhamnus prinoides* is a dense shrub or sometimes appears as small tree. It is spineless and evergreen. It is one of the two representative species with *Rhamnus staddo* of the family *Rhamnaceae* that are only found in Africa (Phillips, 1994). *Gesho* is commonly used for preparation of traditional alcoholic beverages, *tella* and *tej* in Ethiopia. *Rhamnus prinoides* is commonly found in eastern, central and western Africa. It is found in different parts of Ethiopia, both in the wild and as a cultivated plant. It grows at elevations of 1,400 to 3,200m above sea level, in the Montana and reverie forest on the edges of clearings. The closely related species *A. Rich* (Vernacular name, *tседo*) occurs only in the wild at the edges of Montana forest in wooded and scrub land in many parts of Ethiopia. *Prinoides* is cultivated on a large scale as a field crop. It is also grown in-home gardens. The leafy branches are sold fresh, or dried (Fullas, 2003).

From a *gesho* plant leaf, stem and fruits, 20 secondary metabolites have been identified ( Abegaz *et al.*, 1999). All the metabolites are already identified from other plants except one metabolite *geshoidin* unique to *gesho* plant. It is identified as a compound with bitterness character and assumed to give bitterest to the alcoholic beverages *tella* and *tej* (Abegaz and Kebede, 1995). The other metabolites from *gesho* are identified as antimicrobial agents (Paneitz Westendorf, 1999) as pharmaceutical agents (Kartsova and Ganzaha, 2006)

### **2.2.2 Honey**

Honey has been highly appreciated as an alimentary product and has been largely used, since ancient times, either preventing or curing infirmity and illness or in cosmetic manufacturing. Honey is a sugary substance obtained from the nectar of the flowers or from the secretions which come from or lie on the living parts of the plant and which honey bees' crop, transform and combine with their own specific substances and store in the honeycomb of the beehive. Honey is a product extremely rich in sugars of which glucose and fructose are outstanding. Fermentation is an irreversible phenomenon that can run in honey mainly during storage, causing significant economic losses. In such a case, honey presents a characteristic odor, increasing acid flavor and gas bubbles (Carvalho *et al.*, 2005).

Ethiopia is one of the top 10 producers of honey in the world, and it is the largest one in Africa (USAID, 2012). The total volume of honey production in 2011 was estimated to be 39.89 million kilograms (kg) CSA (2012). The country's potential for honey production, the variety of natural honey flavors associated with the country's diverse sources of bee forage, and Ethiopian honey's

desirable qualities, such as low moisture content, have been widely recognized. Ethiopia is also the country with the longest history of marketing honey and beeswax in Africa. Ethiopians use honey in place of sugar to sweeten their foods and to boost their caloric intake. The average household in Ethiopia is composed of six people, and annual honey consumption is estimated to be 10 kg per household. Honey in Ethiopia is generally produced as a cash crop, with yearly sales amounting to 90 to 95 percent of total production. Currently, the majority of honey produced (about 70 percent of the 90 to 95 percent designated for sale) is sold to *tej* houses. The remaining portion is marketed as table honey for general consumption (Tadesse, 2007). Honey is produced in almost all parts of Ethiopia, with distinctive types of honey coming from different regions. Probably the most famous and characteristic in terms of color and taste comes from Tigray. The honey's pure white color (due to bees foraging on Tebeb plant (*Basium clandestinum*)) and its low moisture content have garnered fame; some people even believe that this honey has medicine like properties.

Yellow honey, also referred to as multi-flora honey, is also commonly produced and available in almost all regions of Ethiopia. It is harvested in many different parts of the country and gets its color from the various crops produced. The last type of honey widely produced and marketed is crude red honey. Its main usefulness and popularity among beekeepers comes from its low quality requirements, because *tej* houses buy it in crude, totally unprocessed form to produce an Ethiopian type of mead (Agonafir, 2005).

Fermentation process enhances the nutritional quality of raw ingredient by improving the digestibility of nutrients and inactivating anti-nutritional factors and also improves the acceptability of food. Fermentation of *tej* and *tella* like other traditionally fermented alcoholic beverages relies on the microorganisms present in the substrates, fermentation vats, or equipment's. So, with the variable micro flora of such spontaneous fermentation variability of the product is imminent.

## Chapter Three

### 3.0 Materials and Methods

#### 3.1 Experimental Site

The Experiment was conducted at Wolkite University Department of Food Process Engineering Laboratory.

#### 3.2 Experimental Materials

The materials used for traditional Ethiopian *tej* production were honey, *gesho* (Local and Foreign), saffron, sugar and water. Raw materials were collected from local market.

#### 3.3 Experimental Design

The experiment controls the first factor (local and foreign hops) and the second factor were boiled and immersed.

Table 1 Experimental Design

Type of hop	Processing Method	
	Boiling	Immersing
Foreign	FB	FI
Local	LB	LI

#### 3.4 Processing Methods

##### 3.4.1 Sample Preparation

Collected raw materials local hops were cleaned, cut and chopped and dried while the foreign hop (hop pellet) was found in processed form. Both varieties were boiled and immersed then added into fermentating *tej*.

### 3.4.2 Process of *Tej* preparation

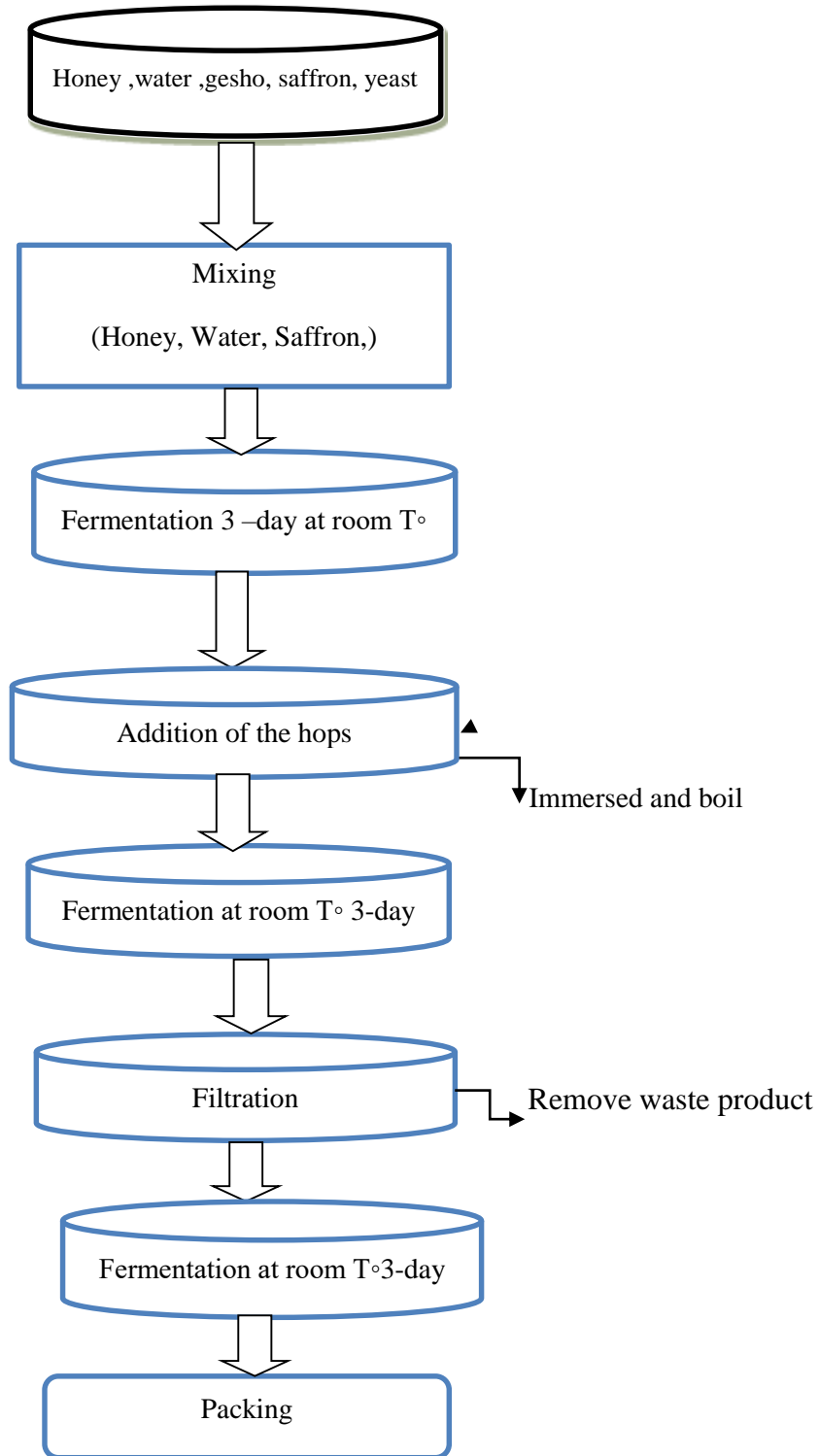


Figure 3.1 *Tej* Preparation Flow Diagram

### 3.4 Physico Chemical Analysis

#### 3.4.1. pH Determination

The pH was measured according to modified electrometric method of (Dornier *et al.*, 1993). The pH meter was standardized with buffer solution of pH 4.0 at 25°C. Finally, the electrode of the pH meter was immersed in a glass beaker containing the samples and reading was obtained from pH meter.

#### 3.4.2 Titrable Acidity (TA)

Titration acidity was determined using the modified method of (Diakabana *et al.*, 2007). 10ml of sample from each treatments were taken and titrated using 0.1M NaOH using phenolphthalein as an indicator until the solution starts to turn and stay pinkish. The amount of NaOH used for the titration was used for calculating the predominate acid, citric acid, found in each treatment.

$$TA = \frac{Titer \times M NaOH \times 0.064}{Sample\ volume} \times 100$$

#### 3.4.3 TSS (Total Soluble Solids) Determination

The refractive indices were measured by using digital refractrometer. Before and after measurement of the refractive index of each sample, the refractrometer was calibrated with distilled water.

#### 3.4.4 Determination of the Specific Gravity

The specific gravity of the samples were determined mathematically according to (Kunze, 1997).

$$Sp = \frac{material\ density}{water\ density}$$

#### 3.4.5 Determination of Alcohol Content

The measurement accomplished spirit indication method. measure SG of *tej* is SG 1, measure 500ml *tej* boil sample down half its original volume added distilled boiled down sample up to exactly a 500ml cooled sample down 20° c measured SG of cooled sample it has SG 2 then subtracted SG1 to SG2 and multiple in 1000 obtained result spirit indication read alcohol strength table.

$$Alcohol \left( \% \frac{v}{v} \right) = \frac{initial\ gravity - final\ gravity}{0.75}$$

### **3.5. Sensory Evaluations**

A 9-Point Hedonic rating scale was used to conduct the sensory acceptability of the products. 15 semi-trained panelists evaluated the organoleptic characteristics (color, bitterness, body, aroma and overall acceptability) of the treatments. The average result was used to determine sum of factors of significance.

### **3.7. Data Analysis**

The data obtained were two replicates to ANOVA using SPSS V 20. Means were differentiated at  $P < 0.05$  level of significance.

## Chapter Four

### 4.0 Result and Discussion

Table 2 Physico Chemical Property

Sample code	pH	TA	AL	TSS	SG
Control	3.8432±0.5828 <sup>ba</sup>	.0810±0.003 <sup>ba</sup>	21.0±0.0	15.7±.0	1.45±0.0033 <sup>ba</sup>
LI	3.7850±0.0495 <sup>ba</sup>	.0781±0.006 <sup>ba</sup>	21.0±0.0	10.2±.0	1.46±0.0177 <sup>ba</sup>
LB	3.6950±0.021 <sup>ba</sup>	.0618±0.003 <sup>ba</sup>	21.0±0.0	12.05±.07	1.46±0.0177 <sup>ba</sup>
FI	3.6550±0.021 <sup>ba</sup>	.0986±0.007 <sup>ba</sup>	21.0±0.0	8.1±.0	1.46±0.0179 <sup>ba</sup>
FB	3.4700±0.113 <sup>ba</sup>	.0819±0.00 <sup>ba</sup>	21.0±0.0	11.4±.0	1.44±0.0177 <sup>ba</sup>

Sample code indicates LB(local boiling),LI(local immersing), FI(foreign immersing),FB(foreign boiling),TSS(total soluble solid),SG(specific gravity),Al(alcohol contents),and TA(Titrable acidity).

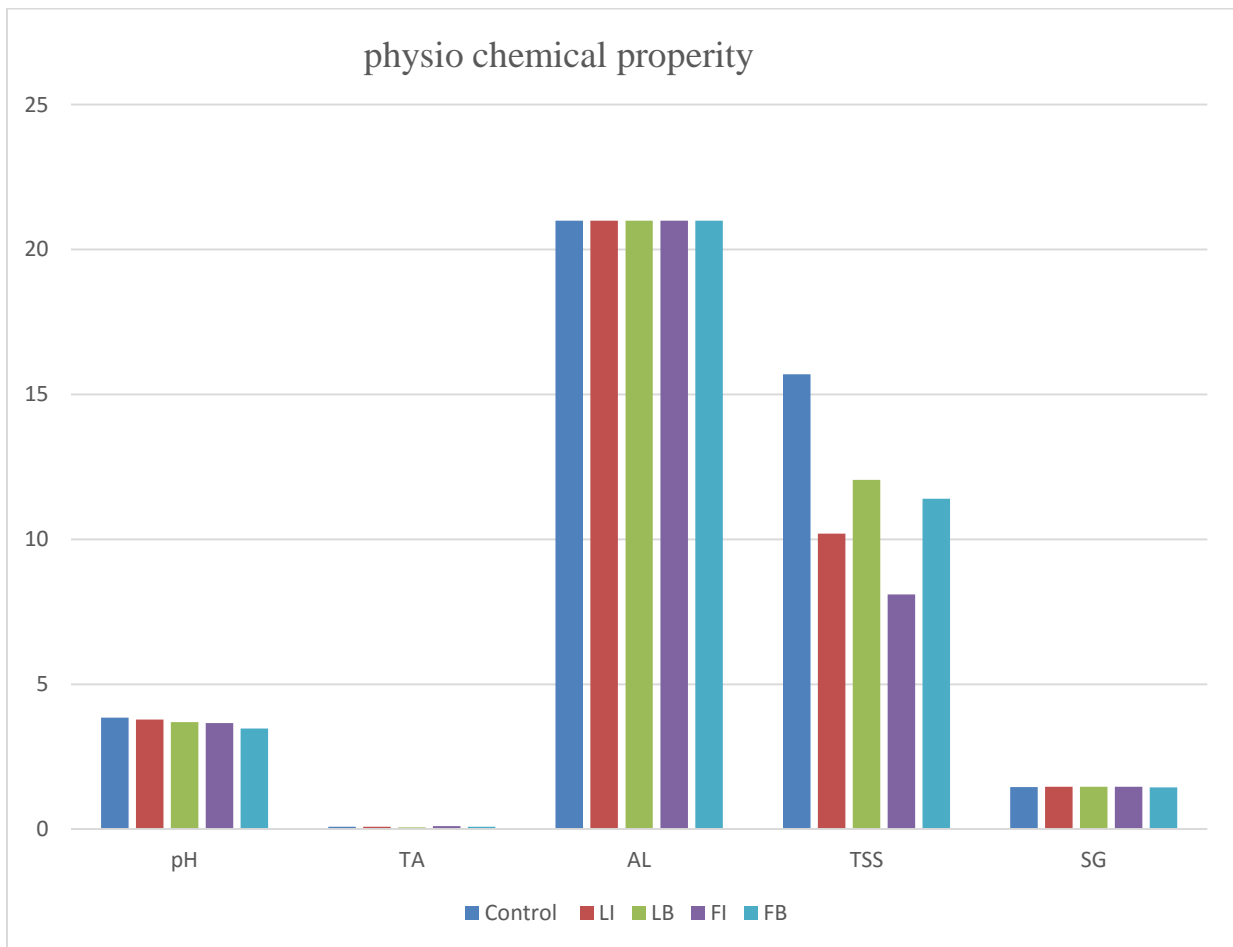
According to Siyum Shewakena June, (2015) Addis Ababa university determined physicochemical property *Tej* pH value ranged from 4.00 to 4.99 but our result pH value of *Tej* lower for different processing method of *gesho* control sample higher pH value compare other sample and also boiled *gesho* lower pH value both local and foreign *gesho*. pH have no significance difference effect processed method and type hops groups, with group and total.

According to Gizaw Debebe July,( 2006 ) specific gravity of *Tej* was 1.00816 our result higher compare this result. This might be due to indirect measurement of the specific gravity and faulty of fermentation profile. Foreign boiled *gesho* had low specific gravity compare to other sample.

According to Gizaw Debebe July,( 2006 ) Alcoholic content *Tej* 13.75-10.90 but our result higher difference occur may be fermentation time vary and the Alcoholics content measure indirect measure not digital material and measuring error and also our result compare each other accordingly not difference boil and immersed and also local and foreign *Gesho* and no significance difference between sample .

TSS different our compare add *Gesho* decrease total soluble solid , immersed one high TSS value compare boiled one and also local more TSS value than foreign because may be foreign *Gesho* fermented sugar to alcoholic.

According to Gizaw Debebe July,( 2006 ) Titrable acidity is 2.0 compare our result lower may the effect different method *Tej* sample and boiled *Gesho* more Titrable acidity and also vary local, foreign and control one may be result vary reading error and may be not shaken properly. foreign immersed high Titrable acidity other total extracted the hop.



4.1 Graphical representation physico chemical property

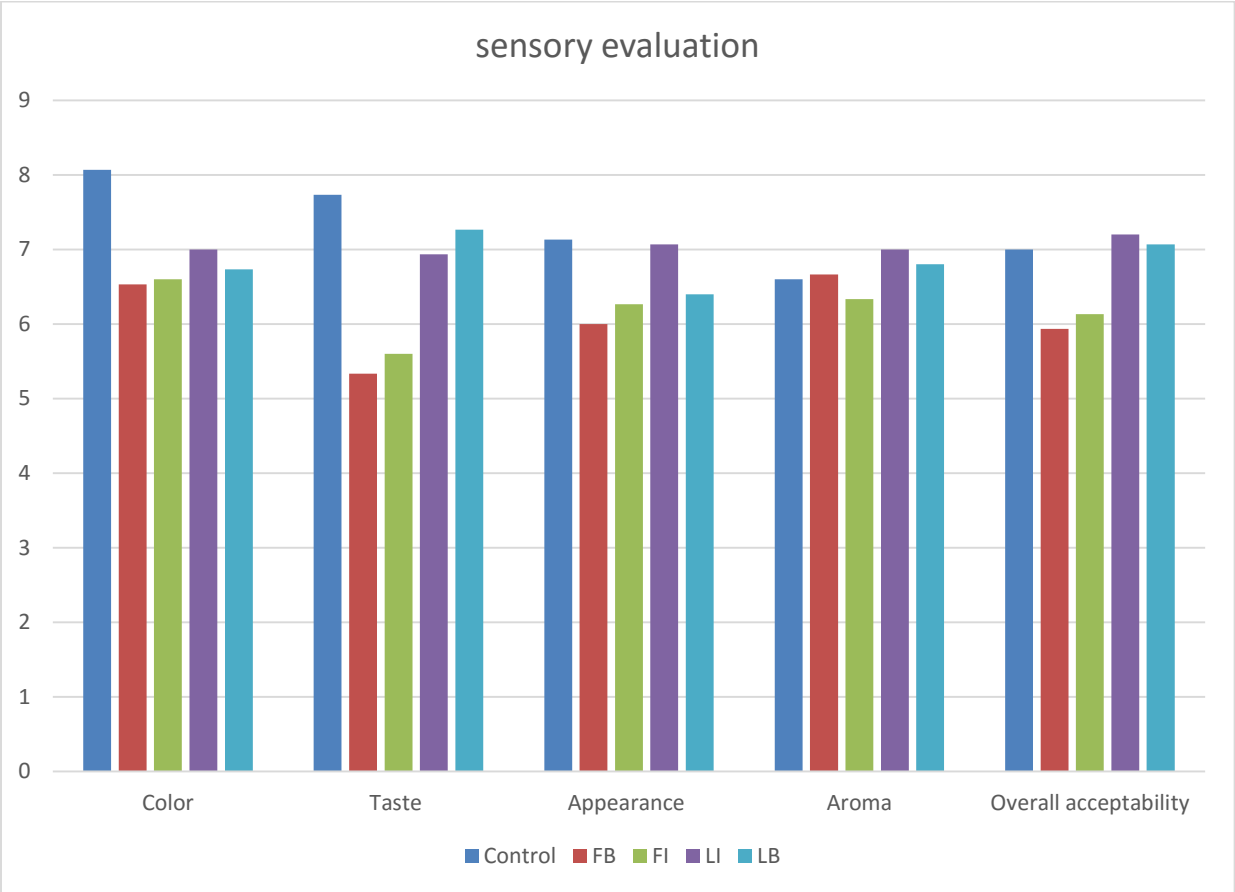
## 4.2 Sensory Evaluation

Table 3 Result of Sensory Evaluation

Sample code	Color	Bitterness	Body	Aroma	Overall acceptability
Control	8.17±.96	7.73±.96	7.13±1.46	6.60±2.13	7.00±1.77
FB	6.53±1.99	5.33±2.16	6.00±1.46	6.67±1.84	5.93±1.53
FI	6.60±1.59	5.60±1.84	6.37±1.03	6.33±1.77	6.13±.92
LI	7.00±1.25	6.93±1.44	7.17±.96	7.00±1.31	7.20±1.08
LB	6.73±1.22	7.36±.96	6.40±1.55	6.80±1.37	7.17±1.47

The sensory evaluation our result good color local immersed ,local boiled better bitterness compare to control and total group, body better result local immersed in case of aroma local immersed and totally over all acceptability good result local immersed and there have significance difference this imply effect processed method and type of *gesho* .

our result sensory evaluation color, taste , bitterness ,body and over acceptability 15 un trained panelists to give good comment's but aroma and taste special foreign high aroma this result may be occur foreign high extracted.



4.2 Graphical Representation Sensory of *Tej*

## Chapter Five

### 5.0 Conclusions and Recommendations

#### 5.1 Conclusions

In the samples of this research, alcoholic content ,pH, Titrable acidity ,specific gravity and total soluble solids were determined for the different processing methods. pH, Titrable acidity , specific gravity have no significance difference between groups and within group. Alcohol and TSS have significance difference between group within group and total sample since they don't have any effect by adding gesho Varity technique of immersed *gesho*/hope. The sensory analysis there is significant of color, aroma ,appearance, overall acceptability in factor of foreign and local and immersed and boiling method. We have such visible effect and individual sample of *Tej*.

#### 5.2 Recommendations

- If it was done with bitterness it was good but there was no available laboratory equipment
- In case of laboratory equipment shortage and agar microbial analyses not done

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## Appendix

### ANOVA Analysis Physico Chemical Property *Tej*

Table 1 ANOVA Analysis Physico Chemical Property *Tej*

		Sum of Squares	Df	Mean Square	F	Sig.
pH	Between Groups	.251	4	.063	18.476	.003
	Within Groups	.017	5	.003		
	Total	.267	9			
Titration Acidity	Between Groups	.001	4	.000	15.206	.005
	Within Groups	.000	5	.000		
	Total	.001	9			
Alcohol	Between Groups	.000	4	.000	.	.
	Within Groups	.000	5	.000		
	Total	.000	9			
Total soluble solid	Between Groups	62.404	4	15.601	15601.000	.000
	Within Groups	.005	5	.001		
	Total	62.409	9			
Specific gravity	Between Groups	.001	4	.000	1.046	.468
	Within Groups	.001	5	.000		
	Total	.002	9			

## ANOVA Analysis Sensory *Tej*

Table 2 ANOVA Analysis Sensory *Tej*

		Sum of Squares	Df	Mean Square	F	Sig.
Color	Between Groups	23.787	4	5.947	2.828	.031
	Within Groups	147.200	70	2.103		
	Total	170.987	74			
Taste	Between Groups	66.613	4	16.653	7.208	.000
	Within Groups	161.733	70	2.310		
	Total	228.347	74			
Aroma	Between Groups	3.653	4	.913	.319	.865
	Within Groups	200.667	70	2.867		
	Total	204.320	74			
Appearance	Between Groups	15.147	4	3.787	2.187	.079
	Within Groups	121.200	70	1.731		
	Total	136.347	74			
overall acceptability	Between Groups	20.667	4	5.167	2.740	.035
	Within Groups	132.000	70	1.886		
	Total	152.667	74			

Descriptive analysis physico chemical property *Tej*

Table 3 Descriptive analysis physico chemical property *Tej*

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		
					Lower Bound	Upper Bound	
pH	control	2	3.8432	.05828	.02000	3.0959	3.6041
	LI	2	3.7850	.04950	.03500	3.3403	4.2297
	LB	2	3.6950	.02121	.01500	3.5044	3.8856
	FI	2	3.6550	.02121	.01500	3.4644	3.8456
	FB	2	3.4700	.11314	.08000	2.4535	4.4865
	Total	10	3.5910	.17240	.05452	3.4677	3.7143
Titration Acidity	control	2	.0810	.00317	.00224	.0525	.1094
	LI	2	.0781	.00634	.00448	.0212	.1350
	LB	2	.0618	.00317	.00224	.0333	.0902
	FI	2	.0986	.00724	.00512	.0335	.1636
	FB	2	.0819	.00000	.00000	.0819	.0819
	Total	10	.0803	.01284	.00406	.0711	.0894
Alcohol	control	2	21.0000	.00000	.00000	21.0000	21.0000
	LI	2	21.0000	.00000	.00000	21.0000	21.0000
	LB	2	21.0000	.00000	.00000	21.0000	21.0000
	FI	2	21.0000	.00000	.00000	21.0000	21.0000
	FB	2	21.0000	.00000	.00000	21.0000	21.0000
	Total	10	21.0000	.00000	.00000	21.0000	21.0000
Total soluble solid	control	2	15.7000	.00000	.00000	15.7000	15.7000
	LI	2	10.2000	.00000	.00000	10.2000	10.2000
	LB	2	12.0500	.07071	.05000	11.4147	12.6853
	FI	2	8.1000	.00000	.00000	8.1000	8.1000
	FB	2	11.4000	.00000	.00000	11.4000	11.4000
	Total	10	11.4900	2.63331	.83273	9.6062	13.3738
Specific gravity	control	2	1.4501	.00338	.00239	1.4198	1.4805
	LI	2	1.4651	.01770	.01252	1.3060	1.6241
	LB	2	1.4651	.01770	.01252	1.3060	1.6241
	FI	2	1.4652	.01792	.01267	1.3042	1.6262
	FB	2	1.4400	.01771	.01252	1.2809	1.5991
	Total	10	1.4571	.01612	.00510	1.4456	1.4686

## Descriptive analysis sensory evaluation of *Tej*

Table 4 Descriptive analysis sensory evaluation of *Tej*

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for		Mini
						Mean		
						Lower Bound	Upper Bound	
Color	control	15	8.0667	.96115	.24817	7.5344	8.5989	
	FB	15	6.5333	1.99523	.51517	5.4284	7.6383	
	FI	15	6.6000	1.59463	.41173	5.7169	7.4831	
	LI	15	7.0000	1.25357	.32367	6.3058	7.6942	
	LB	15	6.7333	1.22280	.31573	6.0562	7.4105	
	Total	75	6.9867	1.52008	.17552	6.6369	7.3364	
Taste	control	15	7.7333	.96115	.24817	7.2011	8.2656	
	FB	15	5.3333	2.05866	.53154	4.1933	6.4734	
	FI	15	5.6000	1.84391	.47610	4.5789	6.6211	
	LI	15	6.9333	1.43759	.37118	6.1372	7.7294	
	LB	15	7.2667	.96115	.24817	6.7344	7.7989	
	Total	75	6.5733	1.75663	.20284	6.1692	6.9775	
Aroma	control	15	6.6000	2.13140	.55032	5.4197	7.7803	
	FB	15	6.6667	1.83874	.47476	5.6484	7.6849	
	FI	15	6.3333	1.67616	.43278	5.4051	7.2616	
	LI	15	7.0000	1.30931	.33806	6.2749	7.7251	
	LB	15	6.8000	1.37321	.35456	6.0395	7.5605	
	Total	75	6.6800	1.66165	.19187	6.2977	7.0623	
Appearance	control	15	7.1333	1.45733	.37628	6.3263	7.9404	
	FB	15	6.0000	1.46385	.37796	5.1893	6.8107	
	FI	15	6.2667	1.03280	.26667	5.6947	6.8386	
	LI	15	7.0667	.96115	.24817	6.5344	7.5989	
	LB	15	6.4000	1.54919	.40000	5.5421	7.2579	
	Total	75	6.5733	1.35740	.15674	6.2610	6.8856	
overall acceptability	control	15	7.0000	1.77281	.45774	6.0183	7.9817	
	FB	15	5.9333	1.53375	.39601	5.0840	6.7827	
	FI	15	6.1333	.91548	.23637	5.6264	6.6403	
	LI	15	7.2000	1.08233	.27946	6.6006	7.7994	
	LB	15	7.0667	1.38701	.35813	6.2986	7.8348	
	Total	75	6.6667	1.43634	.16585	6.3362	6.9971	

