

## Vermouth Production Technology -An overview

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### Abstract

Aperitif wine known as 'Vermouth' is prepared from base wine by adding mixture of herbs and spices or their extract. Different parts of various plants (herbs and spices) such as the seeds, woods, leaves, barks or roots in dry form are used. These additives are infused, macerated or distilled in a base white wine and are added at the various stages of fermentation. The liquid is filtered, pasteurized, and fortified, i.e. additional alcohol is added. Some vermouths are sweetened; however, unsweetened, or dry vermouth tends to be bitter and both have different alcohol levels. It is known as aromatized liquor and it can be considered as a fortified wine. Vermouth prepared from grape fruits is the most common, although vermouths made from mango, plum, apple and sand pear have acceptable physico-chemical and sensory qualities. This review gives comprehensive information on the technology of vermouth production, various spices and herbs used and the commercial potential of non-grape fruits such as, mango, apple, sand pear, plum and tamarind for vermouth production.

**Keywords:** Vermouth, Ethanol, Apple, Mango, Sand pear, Plum, Tamarind.

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the middle of the nineteenth century, the north of Italy, mainly around Turin, and the Chambéry district of France, both areas close to mountains where suitable herbs may be found, became established centers of herb production for vermouth. The quality and type of vermouth depend upon the quality and nature of base wine and on the kind, quality and amounts of various herbs used<sup>5</sup>.

Vermouth has been defined as a fortified wine (alcohol 15 to 21%) flavoured with mixture of herbs and spices. Some of them impart an aromatic flavour while others give a bitter flavour<sup>1</sup>. The vermouth could be sweet or Italian type and the dry or French type. In Italian type, alcohol content varies from 15 to 17% with 12 to 15% sugar while French have 18% alcohol with 4% reducing sugar. The dry vermouth contains less herbs and spices than the sweet. Traditionally, vermouth or aperitif wines are compounded from grape wine by adding herb and spice mixture or their extracts. These beverages are served straight in European countries while in America these are mostly used in the cocktails. While the infusion gives vermouth its unique flavour and aroma, it is precisely that character that causes some people to dismiss vermouth as being medicinal. The antioxidant characteristics of a newly

### Introduction

Vermouth is officially classified as an 'aromatized fortified wine', a tongue-twisting term meaning a base white wine fortified and infused with a proprietary recipe of different plants, barks, seeds, fruit peels, collectively known as botanicals. These types of wines are quite popular in European countries and in USA besides their commercial production in Russia, USSR and Poland<sup>1,2</sup>. The word Vermouth is derived from the German word "Wermut" (or "Wer" means man; "Mut" means courage, spirit, manhood or English 'worm wood' which is *Artemisia absinthium* Linn.<sup>3</sup>). Wormwood is a plant with powerful medicinal and psychoactive qualities and

was used to cure stomach problems, including intestinal worms. Wormwood, however, is a very bitter plant. Wormwood as an ingredient is not in use, but vermouth today is still characterized by a bitter undertone moderated by the botanicals. The addition of wormwood to wine appears to date from early Roman and probably early Greek times, although the production of vermouth itself in Italy did not begin until the eighteenth century. This wine was made for the first time by Antonio in 1786 in Italy by using wormwood<sup>3</sup>. It is believed to be a method developed for enhancing the taste of sour or uncompromising wines with the infusion of a variety of sweeteners, spices, herbs, roots, seeds, flowers, and peels. In

developed vermouth wine were studied comparing with those of three red and three white wines as well as of one rose wine<sup>4</sup>. It has been observed that the usual consumption of one unit from the vermouth is medically acceptable.

Basically, the vermouth is classified into two categories, which are sweet vermouth and dry vermouth, the main difference being the number and types of botanicals used in the recipe.

### Sweet (Italian-Type) vermouth

Sweet vermouth is produced in Italy, Spain, Argentina and other countries as well as in the United States. Typical Italian vermouth is dark amber in colour, with a light Muscat, sweet nutty flavour and a well-developed and pleasing fragrance with a generous and warming taste and a slightly bitter but agreeable aftertaste. The vermouth made in Italy must contain at least 15.5% of alcohol and 13% or more of reducing sugar<sup>6,7</sup>. American vermouths are generally higher in alcohol and somewhat lower in sugar than the Italian. In France, the base wine is normally flavoured by direct maceration of the herbs and spices. The mixed herbs are allowed to macerate in the wine for one or two weeks, with periodic stirring<sup>8</sup>.

In California, a fortified sweet wine of light colour such as a new angelica or white port is used as the base wine for making sweet vermouth. Further, the base wine should be analyzed for copper and iron content. The proper sugar level of wine is maintained using grape concentrate or sucrose. Further, the total amount of water may not exceed 10% of the volume of the vermouth. Citric acid may be used to maintain the total acidity. The alcohol content must be high enough

to allow for dilution when extracts low in alcohol are employed for flavouring. The final alcohol content of the sweet vermouth is usually 17%, total soluble solids 13 to 14%, total acidity about 0.45% and tannic acid about 0.04%. Caramel syrup may be used if the colour is not dark enough. However, it has been recommended that grape concentrate darkened by heating should be used instead of caramel to darken the colour<sup>9</sup>.

### Dry (French-Type) vermouth

Dry vermouths usually have higher alcohol content, lower sugar content and are lighter in colour than the sweet vermouths. Further, these are sometimes more bitter in flavour. In a typical French dry vermouth<sup>8</sup>, the alcohol is 18% by volume, reducing sugar 4%, total acidity (as tartaric acid) 0.65% and volatile acidity (as acetic acid) 0.053%.

The formulae for dry vermouth contain much larger amounts of wormwood and bitter orange peel as compared to sweet vermouths<sup>10</sup>. Aloe, a bitter herb, has also been recommended as an additional ingredient. In the French vermouth, a fewer number of herbs and spices are used than in the Italian vermouth<sup>11</sup>.

A neutral sauterne-type wine is mostly preferred as the base for dry vermouth by California wine makers<sup>8</sup>, which is usually made by fortifying a lot of sauterne low in sulphur dioxide content to 24% alcohol content and then mixing the fortified wine with a sauterne of 12 to 14% alcohol content to give a blend containing 18 to 18.5% of alcohol. Further, the dry vermouths in America are generally pale in colour and lightly flavoured. Carbon is not

recommended to be used as de-colourizing agent in vermouth itself as the carbon absorbs flavouring and aromatic compounds. Moreover, the grapes which are balanced in acidity and sugar content should be used for wine production<sup>12</sup>.

Among those European vermouth producers universally recognized for their unique stylized vermouths are Martini and Rossi of Italy and Noilly Prat of France. Both are leaders in their respective countries, but their vermouths are uniquely different<sup>13</sup>. Martini and Rossi, part of the Bacardi empire, is the world's largest vermouth firm, producing a range of aromatized wines with a respect for tradition merged with modern large-scale wine making. The most popular Martini and Rossi vermouth in the United States is the Rosso, followed by the Extra Dry, then Bianco. Other European vermouth houses universally recognized for their unique stylized vermouths are Cinzano and Stock of Italy and Boissier and Dolin Vermouth de Chambery of France.

The composition of dry and sweet vermouths studied by different scientists from the samples of USA, France and Italy is given in the Table 1.

### Vermouth preparation technology

The vermouth is prepared traditionally from grape by making the base wine, extracting the herbs and spices in wine and brandy mixture, blending the extract with base wine, fortifying the base wine to the desired level of alcohol and finally maturation of prepared vermouth<sup>1</sup>. The basic steps involved in vermouth production have been

**Table 1: Composition of dry and sweet vermouths**

Source	Number of samples	Alcohol (%)			Extract (g/100 ml)			Total Acid (g/100 ml)			Tannin (g/100 ml)		
		Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
<b>Dry</b>													
France	6	17.4	19.3	18.3	3.7	6.1	4.8	0.55	0.66	0.61	0.05	0.08	0.07
United States	77	15.0	22.0	17.7	1.4	7.9	3.8	0.31	0.66	0.50	0.03	0.07	0.04
<b>Sweet</b>													
Italy	20	15.5	17.1	16.1	14.9	20.7	18.6	0.36	0.52	0.28	0.05	0.11	-
Italy	10	13.7	16.9	15.7	14.0	17.2	15.6	0.36	0.52	0.45	0.05	0.11	0.08
United States	100	14.0	21.0	17.1	10.0	19.0	13.8	0.26	0.63	0.45	0.03	0.10	0.06

(Source: Ref. 6, 11)

given in the Fig. 1. The base wine is prepared from grape juice or a concentrate as per the routine method. The essential requirements of a base wine for conversion into vermouth are that the wine should be sound, neutral and cheap. For example, among Italian vermouths, wine from Emilia district is popular which is fairly neutral wine with 10-11% (v/v) alcohol and a low acidity of 0.5-0.6%. It is prepared largely from Ugni Blanc grape. Many Italian producers use refined beet sugar for preparation of the vermouth, although in France mistelas (fortified grape musts) are preferred. Caramel is an important constituent and is carefully prepared<sup>5</sup>. American vermouth is produced if a wine of natural higher acidity is used. It should be fortified with neutral high proof brandy. The extract can be prepared by direct extraction method in which their calculated amount is placed in the base wine till the wine has absorbed the desired flavour and aromas. The wine may be heated during the extraction

process up to 60°C and the container should be covered to minimize the loss of aromas<sup>12</sup>. However, details of the extraction processes differ among various manufactures. Some companies use a type of fractional blending system to maintain consistency in the composition of the botanical extract. It is believed that the more important botanical ingredient include wormwood, coriander, cloves, chamomile, dittany of Crete, orris and quassia. Brandy or alcohol extracts of spices and herbs are available for flavouring the vermouth<sup>11</sup>. Use of brandy in the extraction of flavour can dispense with the need of heating usually carried out in the process with wine. Dry vermouth should not be aged very long, rather should be finished and bottled very young. Sweet or dry vermouth should be low in pH and preserved with SO<sub>2</sub> to prevent the spoilage by *Lactobacillus trichodes*. It may also be flash pasteurized or hot-bottled<sup>6, 12</sup>. Further, the quality and type of vermouth depend upon the quality

and nature of base wine and on the type, quality and amounts of various herbs used. In general, the viscosity of wine, that correlates with the body of the wine the most, can be affected by parameters like ethanol and dry extract concentration of the wine<sup>14, 15</sup>. It has also been observed that ethanol and dry extract of the wine are the constituents that mainly affect its viscosity, while glycerol has a negligible effect due to its low concentration.

### Herbs and spices

The different parts of various plants (herbs and spices) such as the seeds, woods, leaves, barks or roots in dry form are used. The major flavouring constituents of the herbs and spices used in vermouth manufacture have been given in the Table 2.

The quality of herbs and spices is affected by the harvesting and storage conditions. The specimens of the same variety of plant grown under different climatic conditions may differ markedly

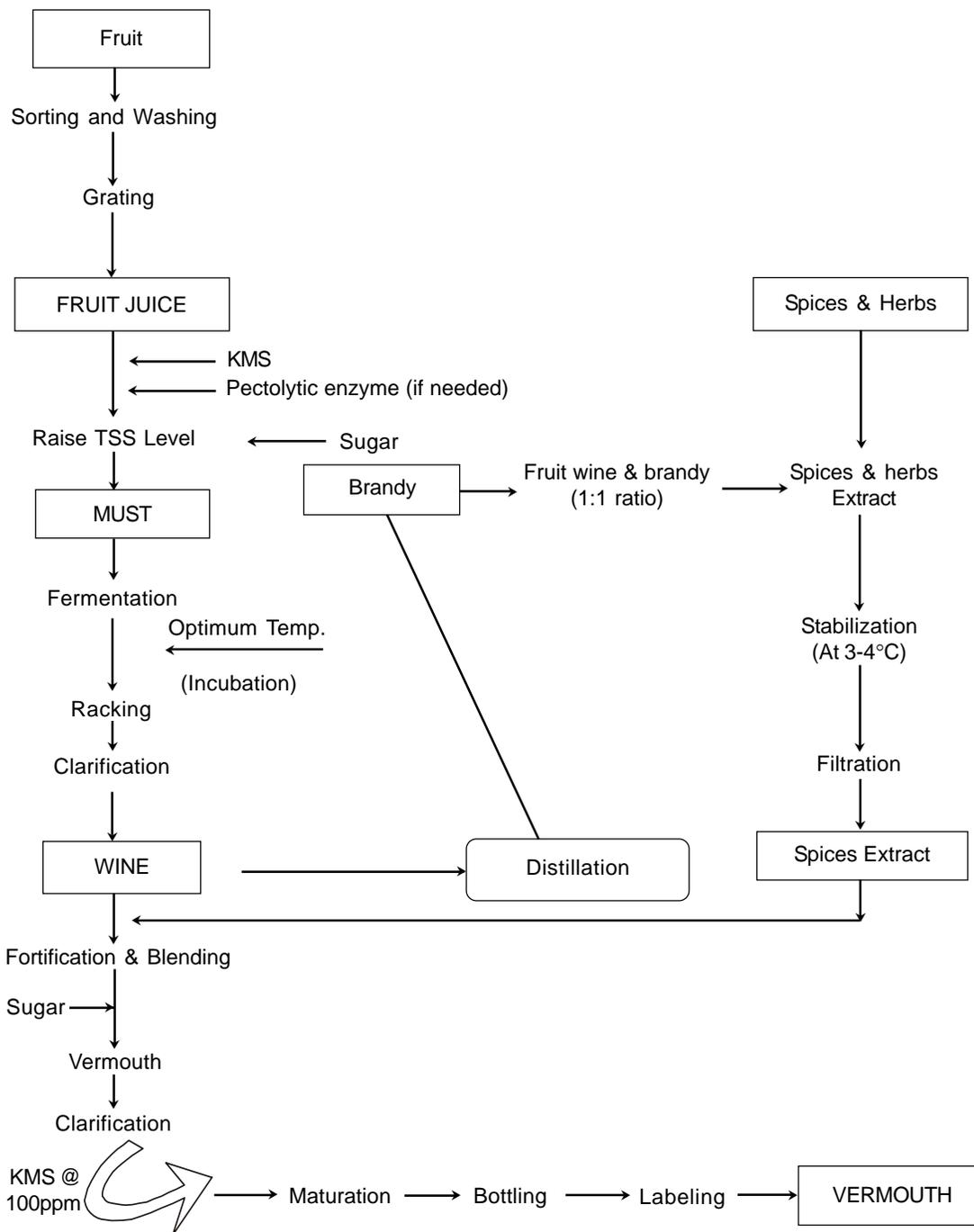


Fig. 1 : Basic processes involved in the preparation of vermouth

and spices should be as fresh as possible.

### Methods of flavouring base wine

Different herbs and spices may require different extraction methods. Thus, various procedures for the extraction of flavours and their subsequent addition to the wine are employed.

**Direct extraction:** It is the simplest method of flavouring the base wine and in this, weighed amounts of the herbs and spices are placed in the wine and leaving them until the wine has absorbed the desired flavours and aromas<sup>10</sup>. To hasten the extraction, the plant materials may be finely ground. However, it may result in undesirable flavouring. The wine is usually circulated or stirred at intervals during extraction. Further, the wine may be heated or room temperature may be applied. However, extraction is usually more rapid at the higher temperature than lower temperature. To minimize the excessive loss of volatile flavours and aromas, the extraction tank should be

in character and quality. It has also been reported that the longer the dried products

are stored before use, the poorer will be their flavour. Therefore, the dried herbs

covered. The partial extraction is preferable to the complete, as the latter

may result in undesirable flavour or aroma. Moreover, the pressing of spent materials is also avoided.

**Preparation of concentrates:** The concentrated extract is prepared by placing the herbs and spices in a special vessel outside the extraction tank and circulating the wine from the tank through the herbs in the extraction vessel until most of the desired substances have been extracted. This extract may then be used to flavour a relatively large volume of base wine. The wine is usually heated during direct extraction<sup>12</sup>. An amount of 0.5 to 1 oz (14.17g to 28.35g) of mixed dry flavouring materials per gallon (4.5 l) of base wine is sufficient for sweet (Italian style) vermouth. However, in case of dry (French style) vermouth, 0.5 oz of the herb

and spice mixture is sufficient. Hot water can also be used to prepare a concentrated extract used in flavouring the base wine. However, water extracts different substances from the herbs and spices than does alcohol or wine. Further, if the softening of herbs and spices is carried by hot water, then easy extraction can be carried out with wine or brandy<sup>8</sup>.

**Other extraction methods:** The brandy or alcohol extracts which are commercially available may be used to flavour a commercial lot of base wine for vermouth. These extracts are also used in small amounts to balance the flavour of a lot of base wine previously flavoured by direct extraction method or by the addition of concentrated wine extract.

It has been reported that in Turin,

Italy, an alcoholic extract made from the infusion of herbs and alcohol is preferred, wherein, herbs are allowed to infuse with alcohol and then this alcoholic extract mixed with alcohol and white wine is distilled<sup>8</sup>. Another method for an extract, consisted of macerating a mixture of herbs in sherry material at 140°F, cooling and allowing standing for three to six weeks<sup>11</sup>. The wine was then removed, the herbs covered with hot wine and allowed to stand for ten days. This wine was blended with first extract. This blend was used to flavour base wine for vermouth. However, the use of a baked sherry as a base did not produce vermouth of highest quality<sup>10</sup>. It has also been recommended that the herbs be first extracted with a wine and brandy mixture of 50% alcohol content

**Table 2 : List of herbs and their plant part used in the production of vermouth**

Common/Commercial name	Scientific name	Plant part used
Allspice	<i>Pimenta dioica</i> (Linn.) Merr. syn. <i>P. officinalis</i> Linn.	Berry
Aloe (socotrine)	<i>Aloe perryi</i> Baker	Plant
Angelica	<i>Angelica archangelica</i> Linn.	Root (occasionally seed)
Angostura	<i>Cuspar febrifuga</i>	Bark
Anise	<i>Pimpinella anisum</i> Linn.	Seed
Benzoin, Gum benzoin tree	<i>Styrax benzoin</i>	Gum
Bitter almond	<i>Prunus amygdalus</i> Batsch	Seed
Bitter orange	<i>Citrus aurantium</i> Linn. var. <i>amara</i>	Peel of fruit
Blessed thistle	<i>Cnicus benedictus</i> Linn.	Aerial portion + seeds
Calamus, Sweet flag	<i>Acorus calamus</i> Linn.	Root
Calumba	<i>Jateorhiza palmata</i> (Lam.) Miers. syn. <i>J. calumba</i> Miers.	Root
Cascarilla	<i>Croton eleuteria</i> Benn.	Bark
Cinchona	<i>Cinchona calisaya</i> Wedd.	Bark
Cinnamon	<i>Cinnamomum zeylanicum</i> Blume	Bark
Clammy sage, Common clary	<i>Salvia sclarea</i> Linn.	Flowers and leaves
Clove	<i>Syzygium aromaticum</i> (Linn.) Merr. et L.M.Perry	Flower
Cocoa	<i>Erythroxylum coca</i> Lam.	Leaves
Common horehound	<i>Marrubium vulgare</i> Linn.	Aerial portion

Common/Commercial name	Scientific name	Plant part used
Common hyssop	<i>Hyssopus officinalis</i> Linn.	Flowering plant
Coriander	<i>Coriandrum sativum</i> Linn.	Seed
Dittany of Crete	<i>Amaracus dictamnus</i> Benth.	Aerial portion+ flowers
Elder	<i>Sambucus nigra</i> Linn.	Flower (also leaves)
Elecampane, Common inula	<i>Inula helenium</i> Hook.f. & Thom.	Root
European centaury	<i>Erythraea centaurium</i> (Linn.) Borkh.	Plant
European meadowsweet	<i>Filipendula ulmaria</i> (Linn.) Maxim.	Root
Fennel	<i>Foeniculum vulgare</i> Mill.	Seed
Fenugreek	<i>Trigonella foenum-graecum</i> Linn.	Seed
Fraxinella, Gasplant	<i>Dictamnus albus</i> Linn.	Root
Galangal, Galingale	<i>Alpinia officinarum</i> Hance	Root
Gentian	<i>Gentiana lutea</i> Linn.	Root
Germander	<i>Teucrium chamaedrys</i> Linn.	Plant
Ginger	<i>Zingiber officinale</i> Rosc.	Root
Hart's tongue	<i>Phyllitis scolopendrium</i> (Linn.) Newman	Plant
Hop	<i>Humulus lupulus</i> Linn.	Aerial Portion+ flower
Lemon balm, Common balm	<i>Melissa officinalis</i> Linn.	Flowering plant
Lesser cardamom	<i>Elettaria cardamomum</i> Mat.	Dried fruit
Lung wort, Sage of Bethlehem	<i>Pulmonaria officinalis</i> Linn.	Aerial Portion+ flower
Lungwort lichen, Lung moss	<i>Styeta polmonacea</i>	Plant (a lichen)
Marjoram	<i>Origanum vulgare</i> Linn.	Aerial Portion+ flower
Masterwort, Hog's fennel	<i>Peucedanum ostruthium</i> (Linn.) Koch.	Root
Nutmeg, Mace	<i>Myristica fragrans</i> Houtt	Seed
Orris, Florentine iris	<i>Iris germanica</i> Linn. var. <i>florentina</i> Dykes	Root
Pomegranate	<i>Punica granatum</i> Linn.	Bark of root
Quassia	<i>Quassia amara</i> Linn.	Wood
Quinine fungus	<i>Fomes officinalis</i> (Vill. ex Fr.) Lloyd	Plant
Rhubarb	<i>Rheum rhapanticum</i> Linn.	Root
Roman camomile	<i>Anthemis nobilis</i> Linn.	Flowers
Roman wormwood	<i>Artemisia pontica</i> Linn.	Plant
Rosemary, Old man	<i>Rosmarinus officinalis</i> Linn.	Flowering plant
Saffron, Crocus	<i>Crocus sativus</i> Linn.	Portion of flower
Sage	<i>Salvia officinalis</i> Linn.	Aerial portion+ flowers
Savory (summer)	<i>Satureja hortensis</i> Linn.	Aerial portion of plant
Speedwell	<i>Veronica officinalis</i> Linn.	Plant
Star anise	<i>Illicium verum</i> Hook.f.	Seed
Sweet marjoram	<i>Majorana hortensis</i> Moench.	Aerial portion+ flower
Thyme, Garden thyme	<i>Thymus vulgaris</i> Linn.	Leaf
Valerian	<i>Valeriana officinalis</i> Linn.	Root
Vanilla	<i>Vanilla planifolia</i> Andr. syn. <i>V. fragrans</i> Ames	Bean
Wormwood	<i>Artemisia absinthium</i> Linn.	Plant
Yarrow	<i>Achillea millefolium</i> Linn.	Plant
Zedoary, Setwell, Curcum	<i>Curcuma zedoaria</i> Rosc.	Root

(Source: Ref. 8, 16)

for ten days, then with wine for five days<sup>17</sup>. Further, a moderate amount of heating can also be employed.

## Preparation of vermouth from non-grape fruits

The method for the preparation of vermouth from grapes is well established. However, other fruits have also been successfully used for the vermouth preparation, as reviewed below:

### Mango vermouth

The production of aromatic wine from mango known as mango vermouth has been carried out successfully<sup>18</sup>. The base wine was made from cv. 'Banganpalli', raising TSS to 22°Brix, adding 100ppm SO<sub>2</sub>, 0.5% pectinase enzyme and carrying out fermentation at 22±1°C using Montrachet strain 522 of *Saccharomyces cerevisiae*. The composition of mango vermouths in respect of pH, total acidity, alcohol, aldehydes and total phenols was comparable to the values reported for vermouths prepared from grapes. The herbs and spices mixture used in this preparation are given in the Table 3. Physico-chemical characteristics and sensory quality of dry and sweet mango vermouth prepared by Martinez *et al*<sup>18</sup> (Formula A, B, C and D) are given in Table 4. The formula A and C were found to be optimum for the preparation of dry and sweet vermouth, respectively.

### Apple vermouth

Apple is produced and relished all-over the world and used both for dessert and processing purposes. In India,

only a small quantity of apple is processed into various products including low alcoholic beverages like cider compared to other advanced countries<sup>19,20</sup>. Spices like *amla* and ginger are known to possess medicinal properties besides antimicrobial activity<sup>19</sup>.

The method reported for the production of apple vermouth was the modified technique of grape vermouth, due to the differences in the type of fruit<sup>21</sup>. In this case it has been observed that base wine had all the desirable characteristics needed to make vermouth. Apple vermouth with different ethanol concentrations (12, 15 and 18%), sugar content (4 and 8%) and spices extract (2.5 and 5.0%) was prepared and

evaluated<sup>22</sup>. It has been observed that composition of vermouth was influenced by different alcohol levels, spices extract or sweetness level in their sensory quality. Level of spices extract (2.5 and 5.0) did not effect TSS (°B), titrable acidity, colour, total sugar, total tannins, volatile acidity, increased mineral contents except for K, esters and aldehyde contents. The physico-chemical characteristics of apple vermouth of different levels of alcohol is given in Table 5. The product with 15% alcohol, 4% sugar and 2.5% spices extract was preferred the most in overall sensory quality. Further, by increasing the acid content, the acceptability of a product with 18% alcohol content can be enhanced considerably.

**Table 3 : Herb mixture for dry and sweet mango vermouths**

Herbs	Amount used (g/l)of base wine			
	Dry wine		Sweet wine	
	A	B	C	D
Black pepper	0.75	1.25	2.5	5.0
Coriander	0.70	1.25	2.5	5.0
Cumin	1.25	2.50	3.0	4.0
Bishop's weed	0.50	1.00	1.50	2.0
Clove	0.25	0.50	0.75	1.0
Large cardamom	0.50	1.00	1.50	1.0
Saffron	0.10	0.10	0.10	0.10
Fenugreek	0.50	1.50	2.0	2.50
Nutmeg	0.25	0.50	0.50	0.75
Cinnamon	0.50	1.00	1.50	2.00
Poppy Seeds	1.00	1.50	2.0	2.50
Ginger	1.00	1.50	2.0	2.50
Flame of Forest	0.25	0.50	0.75	0.75
Lichen	0.25	0.50	1.00	2.00

A, B, C and D= Different formulas (Source: Ref. 18)

**Table 4: Physico-chemical characteristics and sensory quality of mango vermouths**

Herbs mixture formula & type of vermouth	Colour (at 420 nm )	pH	Total acidity (tartaric acid / 100 ml)	Volatile acidity (g. AA/ 100 ml)	Alcohol (%v/v)	Total aldehyde (ppm)	Total phenols (%)	Organoleptic scores (out of 20)
<b>Dry Vermouth</b>								
Formula A	0.420	3.40	0.59	0.088	17.0	15.8	0.055	13.00
Formula B	0.658	3.50	0.60	0.087	17.5	20.9	0.064	11.50
<b>Sweet Vermouth</b>								
Formula C	0.678	3.42	0.59	0.071	17.2	26.4	0.070	15.50
Formula D	0.690	3.50	0.61	0.091	18.0	56.3	0.075	13.60

(Source: Ref. 18)

### Plum vermouth

Attempts to prepare plum vermouth of commercial acceptability have been made<sup>23</sup>. The herbs, spices, the parts used and quantity/l are shown in the Table 6. It has been reported that the increase in the alcohol concentrations increased the aldehydes, ester, phenol content and TSS but acidity and vitamin C decreased. Further, the herbs/spices extract addition, increased the total phenols, aldehydes and ester content of vermouth. The composition of sweet and dry plum vermouths has been given in the Table 7. The sensory evaluation of the products shown that the sweet products were superior to the dry. The sweet vermouth with 15% alcohol content was found to be the best product.

### Sand Pear vermouth

The juice of sand pear can also be converted into vermouth as per the standardized methodology<sup>24</sup>. Dry and sweet vermouths with variable alcohol levels were prepared from sand pear base wine<sup>25</sup>. The conversion of base wine into vermouth increased TSS, acidity, aldehydes,

**Table 5 : Physico-chemical characteristics of apple vermouth at different levels of alcohol**

Characteristics	Alcohol level (%)*			C.D. <sub>p=0.05</sub>
	12	15	18	
Total sugar (%)	9.2	7.8	7.3	0.4
Total soluble solids (°B)	16.0	16.2	16.3	N.S.
Titrateable acidity (% MA)	0.43	0.39	0.37	N.S.
pH	3.36	3.29	3.26	0.04
Ethanol (% v/v)	11.9	15.2	19.2	0.36
Colour (units)				
Red	3.75	2.92	2.40	0.38
Yellow	20.75	20.00	10.60	0.47
Apparent viscosity (flow)	1.62	1.95	2.02	0.03
Free aldehyde (mg/l)	46	46	68	6.03
Total esters (mg/l)	175.7	181.0	246.7	10.60
Volatile acidity (%)	0.046	0.040	0.040	N.A.
Total tannins (mg/l)	633	524	521	33.1

\*Means are irrespective of sugar and spices extract level (Source: Ref. 22)

phenols and esters due to the addition of extracts of herbs/spices. The sweet product having 15% alcohol gave higher acceptability. The herbs and spices and their quantity used were the same as that used for plum. The composition of sand

pear base wine and its vermouth<sup>25</sup> has been given in the Table 8.

### Tamarind vermouth

Tamarind is one of important tropical tree widely grown in India and

**Table 6 : Spices and herbs used in the preparation of plum vermouth**

Common name	Botanical name	Part used	Qty g/l
Black pepper	<i>Piper nigrum</i> Linn.	Fruit	0.75
Coriander	<i>Coriandrum sativum</i> Linn.	Seeds	0.70
Cumin	<i>Cuminum cyaminum</i> Linn.	Seeds	0.50
Clove	<i>Syzygium aromaticum</i> Linn.	Fruit	0.25
Large cardamom	<i>Amomum subulatum</i> Roxb.	Seeds	0.50
Saffron	<i>Crocus sativus</i> Linn.	Flower	0.01
Nutmeg	<i>Myristica fragrans</i> Houtt.	Seed	0.25
Cinnamon	<i>Cinnamomum zeylanicum</i> Beryn.	Bark	0.25
Poppy seed	<i>Papaver somniferum</i> Linn.	Seed	1.00
Ginger	<i>Zingiber officinale</i> Rosc.	Dried root	1.00
Woodfordia	<i>Woodfordia fruticosa</i> Kurz syn. <i>W. floribunda</i> Salisb.	Flower	0.25
Asparagus	<i>Asparagus</i> sp.	Leaves	0.10
Withania	<i>Withania somnifera</i> Dunal	Roots	0.20
Adhatoda	<i>Adhatoda</i> sp.	Leaves	0.25
Rosemary	<i>Rosmarinus officinalis</i> Linn.	Flowering part	0.10

(Source: Ref. 23)

**Table 7 : Physico-chemical characteristics of dry and sweet plum vermouth**

Physico-chemical characteristics	Type of vermouth	
	Dry	Sweet
Total sugar (%)	ND	4.8
Titrateable acidity (% malic acid)	0.81	0.79
Ethanol (% v/v)	15.0	14.5
Volatile acidity (% acetic acid)	0.03	0.04
pH	3.38	3.34
Vitamin C (mg/100m)	3.5	3.2
Total phenols (mg/l)	417	390
Aldehydes (mg/l)	411	112
Esters (mg/l)	204	219

(Source: Ref. 23); ND: Not detected

its fruit can be used for production of wine, but, its wine is not preferred due to high level of acidity. Attempts have been made to convert the fruit wine into vermouth of acceptable quality<sup>26</sup>. In this technique, the base wine was made from tamarind fruit (50g/l), maintaining 0.9% acidity followed by raising TSS to 23°Brix, adding 150 ppm SO<sub>2</sub>, carrying out fermentation with *Saccharomyces cerevisiae* var *ellipsoideus* at a temperature of 27±1°C. Both dry and sweet vermouths having 17% alcohol content were found to be acceptable.

## Legal requirements

The production of vermouth in wineries was illegal until 1936. As per the Liquor Tax Administration Act of 1936 vermouth pays a single tax only, provided, it is made by a bonded winery from fortified wine without addition of more alcohol during manufacture of the vermouth itself. According to the regulations, the product must have the taste, aroma, and other characteristics generally attributed to vermouth. The producer may add an essence (brandy extract of herbs) made with tax-paid brandy which may be made by the vermouth producer or obtained from a manufacturer<sup>11</sup>. However, if essence is used it must be stated in the formula. Further, the base wine may be sweetened with grape concentrate or sucrose. The requirement of separate room or building from other winery premises now no longer applies and the vermouth may be made in any tank on bonded winery premises. It is however, compulsory that the formula showing the ingredients used, details of the process must be filed with the Assistant Regional Commissioner of the Alcohol and

**Table 8 : Physico-chemical characteristics of sand pear base wine and sweet vermouth**

Characteristics	Wine	Vermouth
Total soluble solids (°B)	6.1	13.0
Titrateable acidity (%MA)	0.37	0.43
pH	3.99	3.95
Reducing sugar (%)	-	4.17
Total sugar (%)	-	4.35
Alcohol (% v/v)	10.80	14.95
Volatile acidity (%AA)	0.04	0.04
Ascorbic acid (mg/100m)	6.6	5.5
Aldehydes (mg/l)	103.21	133.15
Total phenols (mg/l)	226.26	264.46
Esters (mg/l)	197.4	268.04
Optical density	0.64	0.58

(Source: Ref. 25)

Tobacco Tax Division of the Internal Revenue Service and the producer must obtain his approval before manufacturing vermouth. Moreover, a natural wine must be used in the making vermouth or the flavoured special natural wines, but such wine may be made with the usual permitted cellar practices. A number of botanicals, flavouring substances and natural substances long used in wines have been the subject of new regulations over the several years. Further, in United States, Regulation of the U.S. Treasury Department, Internal Revenue Service (1961) contains the various legal requirements that apply in the production of vermouth<sup>10</sup>. It has been reported that in USA, it is mandatory that product should be free from thujone.

## Conclusion

Vermouths are prepared from base wine by adding herbs and spices

mixture or their extract, which impart a characteristic aromatic flavour. The quality and type of vermouth depend upon the base wine and the type, quality and amounts of various herbs/spices used. Besides grapes, other fruit juices such as apple, mango, plum and sand pear have shown their potential in the vermouth production. Besides this attempts have been made in production of vermouth from tamarind, however higher acidity is the major hindrance. Fortification of these wines is carried by addition of ethanol (derived from distillation of wine) at particular stage during the process. In addition to their high ethanol content, their distinctive character is due to specialized processes of maturation. Many of the production techniques were devised peculiar to one specific area and helped to give the wine for that area its own individual characteristics. However, economics have forced to modify the

original methods, but, in doing so, attempts were made to retain the flavours, which were originated by the traditional techniques.

## References

1. Amerine MA, Kunkee KE, Ough CS, Singleton VL and Webb AD, The Technology of Wine Making, 4<sup>th</sup> Edition, AVI Publishing Co. Inc, Westport CT, 1980.
2. Griebel C, Gemahlene Wermutkrauter Z Lebensm, *Untersuch u-Forsch*, 1955, **100**, 270-274.
3. Mattick LR and Robinson WB, Changes in volatile acids during the baking of sherry wine by the Tressler baking process, *Am J Enol Vitic*, 1960, **11**, 113-116.
4. Fehér J and Lugasi A, Antioxidant characteristics of newly developed vermouth wine, *Orv Hetil*, 2005, **145**, 2623-2627.
5. Garcia de Lujan A, Puertos Garcia P and Benitez ML, Variedades de Vid en Andalucia, Dir. Investigacion y Extension Agrarias, Consejeria de Agriculture y Pesca Junta de Andalucia, Seville, Spain, 1990.
6. Perez L, Vakarcel MJ, Ganzalez P and Domecq B, Influence of *Botrytis* infection of grapes on the biological aging process of fino sherry, *Am J Enol Vitic*, 1991, **42**, 58-62.
7. Romano P and Suzzi G, Acetaldehyde production in *Saccharomyces cerevisiae* wine yeasts, *FEMS Microbiol Lett*, 1994, **118**, 213-218.
8. Jeffs J, Sherry, 2<sup>nd</sup> Edition, Faber and Faber, London, 1970, p. 268.
9. Goswell RW and Kunkee RE, Fortified wines, *In: Alcoholic Beverages*, AH Rose (Editor), Academic Press, London, 1977, pp. 477-534.
10. Amerine MA, Berg HW and Cruess WV, The Technology of Wine Making, 3<sup>rd</sup> Edition, AVI Publishing Co. Inc, Westport CT, 1967.

11. Rizzo F, La fabbricazione del Vermouth, *Edizione Agricole*, Bologna, 1957.
12. Mattick LR and Robinson WB, Changes in volatile acids during the baking of sherry wine by the Tressler baking process, *Am J Enol Vitic*, 1960, **11**, 113-116.
13. Boyd GD, Vermouth: The aromatized wine, *Hotel F & B*, 2007, March/April Issue.
14. Nurgel C and Pickering G, Contribution of glycerol, ethanol and sugar to the perception of viscosity and density elicited by model white wines, *J Text Studies*, 2005, **36**, 303-323.
15. Yanniotis S, Kotseridis G, Orfanidou A and Petraki A, Effect of ethanol, dry extract and glycerol on the viscosity of wine, *J Food Eng*, 2007, **81**, 399-403.
16. Bravo F, Crianza biologica del vino: procedimiento tradicional de vinos finos de D. O. Jerez y DO Montilla, *Moriles Enol Enoltec Marzo*, 1986, 15-19.
17. Jerez-Xerez-Sherry, Regulations for the Denominations of Origin 'Jerez-Xerez-Sherry' and 'Manzanilla-Sanlucar de Barrameda' and the regulating Council, 1964.
18. Martinez de la Ossa, Caro I, Bonat M, Perez L and Domecq B, Dry extract in sherry and its evolution in the aging process, *Am J Enol Vitic*, 1987, **38**, 293-297.
19. Joshi VK and John S, Antimicrobial activity of apple wine against some pathogenic and microbes of public health, *Alimentaria*, 2002, Nov, 67-72.
20. Sharma RC and Joshi VK, Processing, *In: Apple Cultivation, Improvement and Post Harvest Management*, KL Chadha and RP Awasthi (Editors), Malhotra Publication Co. New Delhi, 2003.
21. Jarczyk A and Wzorek W, Fruit and honey wines. *In: Alcoholic Beverages*, A.H. Rose (Editor), Academic Press, London, 1997, pp. 387.
22. Joshi VK and Sandhu DK, Influence of ethanol concentration, addition of spices extract and level of sweetness on physico-chemical characteristics and sensory quality of apple vermouth, *Braz Arch Biol Technol*, 2000, **43**, 537-545.
23. Joshi VK, Attri BL and Mahajan BVC, Production and evaluation of vermouth from plum fruits, *J Food Sci Technol*, 1991, **28**, 138-141.
24. Joshi VK and Pandey A, Fruit Based Alcoholic Beverages, *Biotechnology: Food Fermentation (Microbiology, Biochemistry and Technology)*, VK Joshi and A Pandey (Editors), Volume II, Educational Publishers and Distributors, New Delhi, India, 1999, p. 719.
25. Attri BL, Lal BB and Joshi VK, Preparation and evaluation of sand pear vermouth, *J Food Sci Technol*, 1993, **30**, 435-437.
26. Joshi VK, Fruit Wine, 2<sup>nd</sup> Edition, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, India, 1998.