

Fruity and Floral Aroma in Alcoholic Beverages

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ARTICLE ID: 050

Introduction

Alcoholic beverages obtained through fermentation of grains, fruits or other sources of sugar is through anaerobic process by certain microorganisms that convert starch or sugar into alcohol. Few additives are added to alcoholic beverages during fermentation to enhance the flavour and aroma of alcoholic beverages. But, in common the fruity and floral aroma of alcoholic beverages could be noticed due to the production of specific aromatic compounds or organic volatile compounds during the fermentation and ageing process.

Yeast and hops are the main sources of fruity and floral aroma compounds in beer. Whereas, volatile compounds present in grapes account for the primary aroma of the wine (Holt *et al.*, 2019). Fruity and floral aromas are in high demand in the beverage industries and there are continuous efforts to improve the aroma of alcoholic beverages through increasing or diversification of the fruity or floral aroma.

History of alcoholic beverages

The history of alcoholic beverages begins with mead, a fermented product of honey. Fermented beverages originated during 7,000 - 8,000 BC. In India, an alcoholic beverage called Sura, distilled product from rice was in use between 3000 - 2000 BC. Around 1850, the French chemist, Louis Pasteur, discovered the biological basis of fermentation and identified the particular role of microbes that initiate and continue the fermentation process (Ray *et al.*, 2016), thereby it leads to a different branch of science that deals with the techniques in alcoholic beverages.

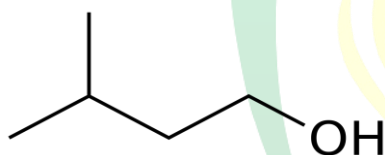
Types of alcoholic beverages

Alcoholic beverages are of two types based on whether the products are distilled or not, viz., un-distilled beverages (wine, beer and sake), these are un-distilled products, hence have low alcoholic content compared to the distilled beverages (brandy, gin, vodka, tequila, rum and whisky), that have high (55 - 75 %) alcohol content as they are distilled products.

Biosynthesis of fruity and floral aromatic compounds in alcoholic beverages

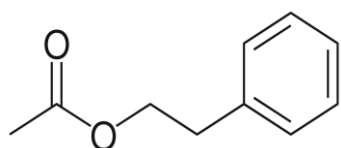
During fermentation, amino acids such as valine, leucine, isoleucine, methionine and phenylalanine are slowly taken up by the yeast cells and assimilated by the Ehrlich pathway to yield a variety of volatile aroma compounds. The major classes of fruity and floral aroma compounds in alcohol are higher alcohols, esters, poly-functional thiols, lactones, furanone, terpenoids, hop-derived ethers and others.

Higher alcohols: Synthesis of higher alcohol during fermentation is by the Ehrlich pathway (Styger *et al.*, 2013). The higher alcohols include isoamyl alcohol, active amyl alcohol (2-methyl butanol), isobutanol and others.



Isoamyl alcohol - Banana, sweet flavour/ aroma

Esters: They are mainly formed during the vigorous phase of primary fermentation by enzymatic chemical condensation of organic acids and alcohols. Most acetate esters are formed by the activity of a single alcohol acetyl-CoA transferase (AATase) enzyme, encoded by the *ATF1* gene (Verstrepen *et al.*, 2003). Esters are synthesized in the cytoplasm of the yeast, but readily leave the cell through the usage of its lipophilic nature.



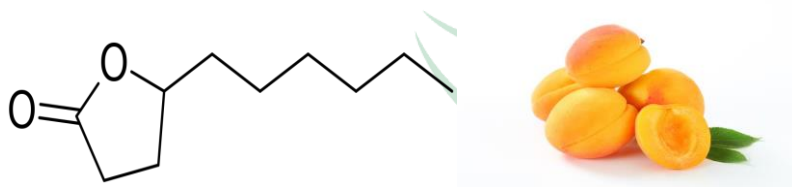
2-Phenylethyl acetate - Roses, honey, apple, sweet flavour/ aroma

Polyfunctional thiols: Carbon-sulfur β -lyase (CS β -lyase), the enzyme involved in the production of Polyfunctional thiols. When this enzyme is overexpressed in yeast, it leads to a very significant increase in the release of polyfunctional thiols during fermentation. Free thiol is released from cysteine-S-4- methyl-4-sulfanyl 2-pentanone by the CS β -lyase Irc7. Cysteine-S-3-sulfanylhexasan-1-ol appears to be a polygenic trait with multiple enzymes involved in it (Holt *et al.*, 2019).



4- methyl-4-sulfanylpentan-2-one - Black currant flavour/ aroma

Lactones: The formation of γ -lactones is dependent on yeast strain, the composition of the wort and fatty acid levels originate from both malt and hops. The biological formation of lactones starts with the oxidation of a fatty acid substrate by lipoxygenases (LOX) through the process called lactonization. Lactonization in beer occurs during mashing and kilning of the malt or by enzymatic catalysis in the wort. During whisky production, a high concentration of lactic acid bacteria can occur spontaneously and these bacteria can cross-feed hydroxylated oleic and palmitoleic acid to distillers and brewer's yeast, which transforms these compounds into γ -decalactone and γ -dodecalactone (Holt *et al.*, 2019).



γ -Decalactone - apricot, peach flavour/ aroma

Furanones: Furanone is formed during kilning of malt and mash boiling and is found in higher concentration in roasted malt varieties. Its concentrations increases during fermentation and depends on the yeast strain used. It is derived partly from α -ketoglutarate catabolism and de novo synthesis of the amino acid threonine during the fermentation (Holt *et al.*, 2019).



4-hydroxy-2,5-dimethyl-3(2H)-furanone - Pineapple flavour/ aroma

Terpenoids: Synthesis of terpenoids occur in *Vitis vinifera* (grapes) and *Humulus lupulus* (hops). Terpenoids are produced by MEP (Methylerythritol 4-Phosphate) and MVA (mevalonate) pathway (Holt *et al.*, 2019) that which lead to a specific aroma of the compound.



Linalool - Citrus flavour/ aroma

Characteristic aromatic compounds in alcoholic beverages

Compounds		Characteristic flavour/ aroma	Threshold level
Higher Alcohols	Isoamyl alcohol	Banana, Sweet	70 mg L ⁻¹
Esters	2-Phenylethyl acetate	Roses, Honey, Apple, Sweet	2 - 3.8 mg L ⁻¹
	Isoamyl acetate	Banana, Estery, Apple	0.6 - 1.2 mg L ⁻¹
	Ethyl hexanoate	Apple, Fruity, Sweet	0.17 - 0.21 mg L ⁻¹
	Ethyl acetate	Solvent like, Sweet	21 - 30 mg L ⁻¹

	Ethyl butanoate	Papaya, Butter, Apple, Perfumy	0.4 mg L ⁻¹
Polyfunctional thiols	4- methyl-4-sulfanylpentan-2-one	Black currant, Fruity	1.5 ng L ⁻¹
	3-sulfanyl-4-methylpentan-1-ol	Exotic fruit, Grape fruit	70 ng L ⁻¹
Lactones	γ -Decalactone	Apricot, Peach	400 μ g L ⁻¹
Furones	4-hydroxy-2,5-dimethyl-3(2H)-furanone	Pineapple, Burnt sugar	0.5 mg L ⁻¹
Terpenoids	Linalool	Citrus, Floral	0.1 mg L ⁻¹

Conclusion

Alcoholic beverages have been a part of mankind for centuries. Even at present the noticeable amount of revenue for any of the government is through alcoholic beverages. The varied palatable flavours are of consumer interest and hence, industries are of strong competition to withhold their trade name in a competitive world through enhancement or by modifying the flavour and aroma of alcoholic beverages. India with a diversity of cultures there is a way to explore traditional alcoholic beverages prepared by varied tribal communities and hence, can improve the socio-economic lifestyle of tribal communities through the Geographical Indication (GI) tag. Alcoholic beverages aid us with beneficial effects if consumed in a proper quantity and there is a need to educate mankind with respect to these beverages.

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