

FOOD PRODUCTS

by

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FOREWORD

This book is written for everybody interested in the preparation of food from the manufacturing plant executive, the food chemist, and the food salesman, right down to the housewife.

The author's knowledge of the subject is based on scientific training and many years of practical, first-hand experience in the manufacture of foods. In addition to compiling the results of his own experience, he has included methods developed and used by other specialists in the field.

Whether the food manufacturer has an old, well-established business or is just starting up a small plant, it is hoped that this book will be an essential part of his equipment. To the established manufacturer, it presents the latest developments and the newest scientific methods in the field of food production. To the beginner, it offers the fundamentals on materials and methods, without which he cannot hope to be successful.

Although the production of good, nutritious food is still an art, as it has always been, in this age of rapid scientific development and ever-increasing knowledge, it is fast becoming an exact science. The food manufacturer must plan wisely and prepare his products scientifically and with understanding. This book presents the manufacture of food as a series of operations governed by well-defined physical, chemical, and bacteriological principles which must be understood and carefully followed for good results.

Here are scientific, factory-tested formulas for making hundreds of commercial food products in the canning, flavoring, beverage, confectionery, bakery, condiment, dairy, meat, fish, and allied industries. The sections on plant sanitation and food handling present the latest scientific methods of hygienic control in the food industry. The most modern developments in the fields of dehydration and freezing of fruits and vegetables are completely discussed in a comprehensive chapter on the subject.

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CHAPTER I
BASIC FOOD INGREDIENTS

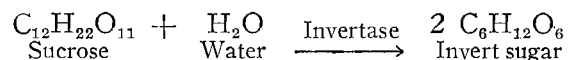
ETHYL OR GRAIN ALCOHOL

Among the raw materials used in the food industries, ethyl alcohol stands out as one of the most important. It is also known as grain alcohol and cologne spirits. Ethyl alcohol is obtained by the fermentation of sugar solutions and saccharified mashes of starch-containing substances. There is also a substantial quantity produced synthetically.

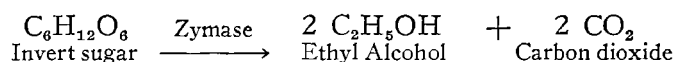
The sugar content of molasses is a cheap source of alcohol. It accounts for almost 75% of the alcohol produced. Blackstrap molasses, a by-product of cane sugar mill operations, containing 50 to 60% sugar by weight, is principally used. The sugar in blackstrap molasses is present as sucrose, $C_{12}H_{22}O_{11}$, and glucose or grape sugar (invert sugar), $C_6H_{12}O_6$.

Alcohol is produced from molasses by a fermentation process in which the sugars are converted to alcohol by the action of enzymes. The molasses is made into a mash, so that the final concentration of sugar falls within a range 15 to 25% by weight. Cultured yeast is then added in quantities ranging from 3 to 10% by volume. This results in a vigorous fermentation.

The yeast has a double action upon the sugar. This is brought about by the presence of two enzymes in the yeast, invertase and zymase. Invertase converts the sucrose into invert sugar.



The zymase then converts the invert sugar into ethyl alcohol and carbon dioxide.



Temperature and the amount of nutrients added to the mash are carefully controlled to sustain the vigorous activity of the yeast. The yeast itself does not undergo any change during the 36 to 48 hours that it takes to yield the maximum amount of alcohol, but merely acts as the agent for converting sugar to alcohol. The resulting alcohol content may amount to from 6 to 12%. The mash is then redistilled twice to remove the aldehydes, esters and fusel oils, which impart an undesirable odor to alcohol. Among the by-products recovered from the purification of alcohol are carbon dioxide, potash for fertilizers, vitamin concentrates for feedstuffs, and binders for the foundry and coal processing industries.

Starch, in the form of grain, when cooked with water and then treated with barley malt is converted by the diastatic enzymes into sugar. Yeast will then ferment this sugar into alcohol. A method, known as the amyl process, saccharifies and then ferments starches into sugars and alcohol. This process had its origin in a study made by Dr. Calmette of the so-called *Chinese yeasts*. The molds are able to saccharify starch rapidly and the combination of yeasts and mold converts the starch to sugar and the sugar to ethyl alcohol in the mash. Very little alcohol, however, is made in this country by this method. Synthetic ethyl alcohol is also produced by a number of methods.

PROPERTIES OF ETHYL ALCOHOL

Formula	C ₂ H ₅ OH
Molecular weight	46
Also known as	Grain alcohol Fermentation alcohol Cologne spirits Spirits of wine
Color	Colorless
Odor	Ethereal, vinous
Taste	Pungent
Other properties	Liquid, volatile
Specific gravity	0.7851

Boiling point	78.4° C.
Solubility	Soluble in water, ether, etc.
Grades	Absolute alcohol 99.80% Rectified spirit 95% or more Cologne spirit of pure distillate 95-96% alcohol content.

ALDEHYDES

These compounds are aromatic fruity liquids, utilized to reinforce flavor, especially of strawberry, raspberry, cherry, pineapple, orange, lemon, lime and many other fruit products. Aldehydes are expensive and, being very powerful, must be used with care.

AMYL ALCOHOL

This is a colorless oily liquid having a penetrating characteristic odor. One part is soluble in 40 parts water and it is miscible with alcohol, ether and chloroform. It is obtained in the purification of ethyl alcohol and extensively used for flavoring whisky, other liquors and fruit essences.

VANILLIN

Vanillin is obtained as the methyl and ethyl derivatives, ethyl vanillin being the stronger of the two in flavor. They are both crystalline and excellent for flavoring liquids and foods. They should be used sparingly since the flavor becomes more pronounced upon standing.

COUMARIN

Coumarin occurs as colorless aromatic crystals. It is used for flavoring liquids and foods, and to reinforce the vanillin flavor in food products. Generally coumarin may be substituted up to one third of the total vanillin content.

GLYCERIN (GLYCEROL)

Glycerin is a liquid obtained by the hydrolysis of vegetable or animal fats or fixed oils and then purified by distillation. If olive oil, which consists principally of glyceryl oleate, is saponi-

fied with alkali, e.g., sodium hydroxide, sodium oleate, a soap, and glycerin are the resulting products. Glycerin is also produced by the fermentation of sugars, wines, beer, bread and other similar products.

Pure glycerin is a colorless, odorless, sweet-tasting, viscous, high-boiling, substantially non-volatile liquid, containing not less than 95% glycerin. It finds wide employment in the preparation of base extracts for flavoring purposes, in food color concentrates, in the extraction of drugs and in many other procedures. Glycerin is soluble in all proportions in water and alcohol and is insoluble in most other organic solvents.

Because of its efficiency as a moistening agent, glycerin is very useful to the baker and confectioner. It retards the drying out of cakes and icings, keeping the products fresh. It has been recommended for the prevention of mold growth in bakery goods, and replaces part of the egg in cake recipes, making the product lighter. Glycerin is used in candy both as a sweetening and preservative ingredient. Many delicatessen formulas for pickles, fish and meat products also use glycerin. In another section, there will be found advanced information on the application of glycerin in many important branches of the food industry.

PROPYLENE GLYCOL

Propylene glycol is a viscous hygroscopic liquid that is now extensively used in the food field as a solvent for flavors. It dissolves synthetic flavoring substances and some essential oils. These solutions can be diluted with water. Due to the penetrating properties of propylene glycol, flavoring agents dissolved in it are carried into and distributed evenly through the product to be flavored. It also serves as a good moistener in bread, cake, confectionery, chocolate, coconut and many other products. It is now approved by the Pure Food and Drug Department of the United States.

SOLUBILITIES OF FLAVORING AGENTS IN
 PROPYLENE GLYCOL—WATER
 MIXTURES AT 25° C

Propylene Glycol	100	80	60	40	20
Water	—	20	40	60	80
Flavoring Agent	Per Cent by Weight				
Amyl acetate	Miscible	Miscible	Miscible	1.48	1.34
Benzaldehyde	Miscible	18.97	4.62	1.80	0.82
Cassia oil	Miscible	3.31	0.85	0.69	0.21
Citral	Miscible	0.35	0.17	0.10	0.04
Clove oil	Miscible	1.19	0.26	0.24	0.12
Coumarin	7.70	5.05	2.30	0.50	0.32
Ethyl acetate (99%)	Miscible	Miscible	Miscible	11.65	8.09
Ethyl formate	Miscible	Miscible	Miscible	—	17.45
Ethyl vanillin	14.20	10.80	5.20	1.84	0.79
Eucalyptol	19.90	4.75	1.73	0.35	0.25
Isoamyl formate	Miscible	5.22	4.51	1.68	1.53
Lemon oil	0.81	0.52	0.32	0.13	0.03
Methyl anthranilate	Miscible	Miscible	Miscible	—	—
Methyl salicylate	17.05	—	—	—	—
Nutmeg oil	1.53	0.34	0.17	0.14	0.11
Orange oil	0.26	0.13	0.08	0.06	0.03
Phenyl ethyl alcohol	Miscible	Miscible	Miscible	18.95	3.11
Sassafras oil	2.02	1.21	0.20	0.12	0.08
Vanillin	20.20	20.10	12.60	5.85	2.09

SOLUBILITY OF ETHYL VANILLIN
 IN PROPYLENE GLYCOL—WATER MIXTURES

Per Cent Propylene Glycol by Volume	Ounces Ethyl Vanillin per Gallon Solvent Mixture at °F					
	32	50	68	77	86	104
0	0.20	0.27	0.37	0.45	0.55	0.84
20	0.33	—	—	1.07	—	—
40	0.61	—	—	2.54	—	—
60	2.40	—	—	7.48	—	—
80	6.41	—	—	16.65	—	—
100	8.00	—	—	23.00	—	—

SOLUBILITY OF VANILLIN
IN PROPYLENE GLYCOL—WATER MIXTURES

<i>Per Cent Propylene Glycol by Volume</i>	<i>Ounces Vanillin per Gallon Solvent Mixture at °F</i>					
	32	50	68	77	86	104
0	0.47	0.68	1.07	1.40	1.80	3.10
20	0.67	1.33	1.60	2.87	4.00	8.42
40	1.66	2.66	4.00	8.41	11.68	41.70
60	5.10	8.01	13.35	19.75	33.38	88.00
80	10.57	16.69	26.70	32.03	46.73	93.50
100	10.32	16.7	28.04	32.70	46.73	80.10

SOLUBILITY OF COUMARIN
IN PROPYLENE GLYCOL—WATER MIXTURES

<i>Per Cent Propylene Glycol by Volume</i>	<i>Ounces Coumarin per Gallon Solvent Mixture at °F</i>					
	32	50	68	77	86	104
0	0.12	0.17	0.22	0.27	0.34	0.52
20	—	0.18	0.33	—	0.53	0.87
40	—	0.33	0.53	—	1.20	2.40
60	—	1.60	2.68	—	3.74	6.67
80	—	3.34	5.34	—	9.35	17.4
100	—	4.94	8.80	—	14.41	26.7

TRIACETIN

Glycerin forms esters with acetic acid, known as mono-, di-, and triacetin, which are used as solvents.

Triacetin is a colorless liquid having a boiling point of 275 to 280° C. It is free from odor, non-toxic and a very good solvent for oils, ethers and esters. It hydrolyzes in the presence of water and should not be used with it.

AMYL AND ETHYL ESTERS, ETHERS AND ALDEHYDES

These are all aromatic chemicals used to augment certain flavors.

The acids used in combination with flavoring substances are formic, acetic, butyric, propionic, lactic and others.

The esters result from the action of organic acids on alcohols. They differ in the number of carbon atoms and physical properties, such as odor, boiling point, etc. A pure ester is always free from water and alcohol. It should be clear when dissolved in benzene and, in some cases, in liquid paraffin.

ESTERS, ALDEHYDES, ETHERS AND KETONES

Amyl acetate	Imparts fruity, ethereal flavor
Amyl benzoate	Imparts cherry, plum, prune flavor
Amyl butyrate	Imparts fruity, ethereal flavor
Amyl formate	Imparts apricot, peach flavor
Amyl isobutyrate	Imparts fruity, ethereal flavor
Amyl propionate	Imparts apple, pineapple, strawberry flavor
Amyl valerate	Imparts peach, pineapple flavor
Butyl acetate	Imparts pear, raspberry, pineapple flavor
Butyl butyrate	Imparts banana, pear, butter flavor
Cinnamyl propionate	Imparts strawberry, raspberry, grape flavor
Ethyl acetate	Imparts fruity, ethereal flavor
Ethyl anthranilate	Imparts grape, winelike flavor
Ethyl benzoate	Imparts strawberry, cherry flavor
Ethyl butyrate	Imparts pineapple flavor
Ethyl formate	Imparts apricot, peach, pineapple flavor
Ethyl propionate	Imparts apple, pineapple flavor
Ethyl sebacate	Imparts grape, peach flavor
Ethyl valerate	Imparts apple, peach, pineapple flavor
Ethyl oxyhydrate (Rum Ether)	Imparts rum, ethereal flavor
Ethyl anthranilate	Imparts grape flavor
Isobutyl acetate	Imparts raspberry flavor
Methyl anthranilate	Imparts grape flavor
Methyl ionone	Imparts raspberry, strawberry flavor
Methyl salicylate	Imparts wintergreen, root beer flavor
Oenanthic ether	Imparts cognac flavor
Phenyl acetic aldehyde	Imparts apricot, cherry, pistachio flavor
Phenyl butyl ketone	Imparts cherry, peach, strawberry flavor

Phenyl ethyl butyrate	Imparts strawberry, raspberry, peach flavor
Phenyl ethyl cinnamate	Imparts peach, apricot, cherry flavor
Rhodinol butyrate	Imparts in traces, cherry, raspberry, strawberry flavor

HIGHER ALDEHYDES AND ALCOHOLS

Octyl alcohol C ₈	Imparts rose, tuberose flavor
Nonyl alcohol C ₉	Imparts lemon, lime, orange flavor
Decyl alcohol C ₁₀	Imparts orange flavor
Undecyl alcohol C ₁₁	Imparts lilac, lily flavor
Duodecyl alcohol C ₁₂	Imparts lemon, orange flavor
Heptyl aldehyde C ₇	Imparts strawberry flavor
Octyl aldehyde C ₈	Imparts jasmine, rose flavor
Nonyl aldehyde C ₉	Imparts orange, lemon, lime flavor
Decyl aldehyde C ₁₀	Imparts citrus flavor
Undecyl aldehyde C ₁₁	Imparts lily, violet flavor
Duodecyl aldehyde C ₁₂	Imparts orange, lemon, lime flavor
Peach aldehyde C ₁₄	Imparts cherry, peach, plum flavor
Apricot aldehyde C ₁₅	Imparts apricot, peach flavor
Strawberry aldehyde C ₁₆	Imparts raspberry, strawberry flavor
Cherry aldehyde C ₁₇	Imparts cherry pit-like flavor
Cocoanut aldehyde C ₁₈	Imparts cocoanut flavor
Pineapple aldehyde C ₁₉	Imparts pineapple flavor
Raspberry aldehyde C ₂₀	Imparts raspberry, cherry, currant flavor
Fruit aldehyde C ₂₂	Imparts fruity flavor
Citral	Imparts lemon flavor
Diacetyl	Imparts butter flavor

VOLATILE OR ESSENTIAL OILS

For all practical purposes, volatile or essential oils may be described as being aromatic, oily, generally liquid but sometimes semi-liquid or solid. The oils volatilize or, upon heating, evaporate without decomposition.

Essential oils may be prepared as follows:

- 1 By pressure, as the oils of lemon, lime, orange and grape fruit.
- 2 By distillation with water, or passing a current of steam

through a distilling flask containing the matter to be extracted.

- 3 By fermentation and subsequent distillation with water, as with essential oils of mustard and bitter almonds. These seeds contain no ready essential oil so they are crushed, left in contact with water, and, due to the action of nitrogenous ferments, the essential oil is formed. This is then recovered by distillation with water.
- 4 By transferring scents of various plants by immersion in a fixed oil devoid of odor, such as olive oil or lard. The aromatic odor is finally collected by extraction with ethyl alcohol, is used as is or redistilled.
- 5 By extraction with low-boiling solvents, either by percolation or maceration, recovering the solvent by distillation, and collection of the essential oil.

The component ingredients of essential oils consist of terpenes, aldehydes, ketones, acids, phenols, alcohols, esters, ethers and sulfur compounds. Essential oils, generally, are liquids lighter than water but there are several that are heavier.

ESSENTIAL OILS

Angelica oil

Solubility in alcohol: 1 part in 12 parts of 90% strength
 Flavor: Spicy
 Use: Gin, cordials

Anise oil

Solubility in alcohol: 1 part in 3 parts of 90% strength
 Flavor: Sweet, licorice
 Use: Candy, cordials

Bergamot oil

Solubility in alcohol: 1 part in 2 parts of 80% strength
 Use: Flavoring medicines and perfume

Birch tar oil

Solubility in alcohol: 1 part in 3 parts dehydrated alcohol
 Use: Flavor in leather, soap, for insect bites

Bitter almond oil

Solubility in alcohol: 1 part in 2 parts 70% strength
Flavor: Almond
Use: Cherry syrups

Bitter orange oil

Solubility in alcohol: 1 part in 5 parts 95% strength
Flavor: Orange
Use: Flavor

Calamus oil

Solubility in alcohol: 1 part in 2 parts 70% strength
Flavor: Spicy
Use: Spice

Cardamom oil

Solubility in alcohol: 2 parts in 5 parts 70% strength
Flavor: Spicy
Use: Cordial, spice

Cassia oil

Solubility in alcohol: 1 part in 2 parts 80% strength
Flavor: Spicy
Use: Fountain flavors

Caraway oil

Solubility in alcohol: 1 part in 8 parts 80% strength
Flavor: Spicy
Use: Cordial, spice, kummel

Cedar oil

Solubility in alcohol: 1 part in 6 parts 95% strength
Flavor: Tobacco-like
Use: Rum

Carrot oil

Solubility in alcohol: 1 part in 5 parts 95% strength
Flavor: Carrot-like
Use: Soups

Celery oil

Solubility in alcohol: 1 part in 8 parts 90% strength
Use: Fountain syrup, soup

Cinnamon oil

Solubility in alcohol: 1 part in 3 parts 70% strength
Flavor: Spicy
Use: Flavor

Clove oil

Solubility in alcohol: 1 part in 2 parts 70% strength
Flavor: Spicy
Use: Flavor

Chamomile roman oil

Solubility in alcohol: 1 part in 2 parts 80% strength
Flavor: Sweet
Use: Flavor, vermouth

Coriander oil

Solubility in alcohol: 1 part in 3 parts 70% strength
Flavor: Spicy
Use: Cordial, spice

Cognac

Solubility in alcohol: 1 part in 8 parts 80% strength
Use: Whiskey flavors

Fennel oil

Solubility in alcohol: 1 part in 9 parts 90% strength
Flavor: Sweet, licorice
Use: Cordial

Galanga

Solubility in alcohol: 1 part in 7 parts 95% strength
Flavor: Camphor-like
Use: Ginger

Ginger oil

Solubility in alcohol: 1 part in 7 parts 95% strength

Flavor: Spicy
Use: Ginger ale

Juniper oil

Solubility in alcohol: 1 part in 4 parts 95% strength
Use: Gin flavors

Hop oil

Solubility in alcohol: 1 part in 1 part 95% strength
Use: Beer flavor, coffee, maple, celery

Lemon oil

Solubility in alcohol: Clearly soluble in 95% strength; forms
cloudy liquid in weaker concentrations
Flavor: Lemon
Use: Lemon drinks, bakery goods

Lemon oil; terpeneless

Solubility in alcohol: Clearly soluble in 80% strength; maybe
as much as 14 times stronger than
lemon oil; will not oxidize
Flavor: Lemon
Use: Baking goods, gelatin and drink powders

Lovage oil

Solubility in alcohol: 1 part in 3 parts 80% strength
Flavor: Maple
Use: Condiments, foods

Lime oil

Solubility in alcohol: Clearly soluble in 95% strength; forms
cloud in 90%
Flavor: Lime
Use: Lime drinks, ginger ale, candy

Laurel oil

Solubility in alcohol: 1 part in 2 parts 70% strength
Flavor: Camphor-like, strongly aromatic odor
Use: Liquors

Mace oil

Solubility in alcohol: 1 part in 3 parts 90% strength
Use: Doughnut flour, liquors, foods

Marjoram oil

Solubility in alcohol: 1 part in 1 part 85% strength
Use: Food seasoning

Mandarin oil (Tangerine oil)

Solubility in alcohol: Clearly soluble in 95% strength
Use: In orange flavors for bouquet

Neroli oil (Orange flower oil)

Solubility in alcohol: 1 part in 2 parts 80% strength
Flavor: Bitter
Use: Flavors and perfume

Neroli oil (Portugal oil)

Solubility in alcohol: Clearly soluble in 95% strength
The pressed oils are Italian, West Indian and Californian; there is also the extracted kind
Flavor: Orange-like odor
Use: Flavor tone in soft drinks, perfume

Nutmeg oil

Solubility in alcohol: 1 part in 3 parts 90% strength
Use: Doughnut flour, soft drinks

Orris oil

Solubility in alcohol: 1 part in 1½ parts 80% strength
Odor: Violet-like odor
Use: Fruit flavors

Origanum oil

Solubility in alcohol: 1 part in 3 parts 70% strength
Use: Liquors, sometimes used where thyme is called for

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