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MARKETING INDUSTRIAL MOLASSES IN THE UNITED STATES

Economic Research Service

U. S. DEPARTMENT OF AGRICULTURE

PREFACE

This report supplements and brings up to date much of the information in earlier Department of Agriculture publications. These include:

The Marketing of Feed Molasses. L. John Kutich. Prod. and Mktg. Admin., Feb. 1950.

Marketing Industrial Molasses. B. K. Doyle, Agr. Inform. Bul. 82, Dec. 1951.

Marketing Molasses for Livestock Feed. Frederick J. Poats and Ralph N. Parker. Mktg. Res. Rpt. 132, Sept. 1956.

Transportation in Marketing Molasses for Feed. Frederick J. Poats. Mktg. Res. Rpt. 149, Jan. 1957.

Marketing Molasses in the Feed Mixing Industry. Frederick J. Poats. Mktg. Res. Rpt. 174, May 1957.

The study on which the report is based was made on the recommendation of the Sugar Research and Marketing Advisory Committee.

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SUMMARY

Industrial molasses is molasses used for purposes other than human consumption. It is an important raw material for feed manufacture and for the making of yeast, citric acid, vinegar, and ethyl alcohol. Most industrial molasses is a joint product with sugar of minor economic importance to the sugar industry. In all of the major uses of molasses, substitute raw materials are available, their use being determined largely by relative prices and technical convenience.

World trade in molasses amounts to about 20 percent of world production. The United States is the largest importer, although its share has been declining since 1956, being less than half the world total since 1960 compared with about two-thirds before 1956. Since 1960, Mexico and the Caribbean area have supplied about half of world molasses exports.

U.S. net imports of molasses during 1948-51 averaged about 46 percent of total U.S. supplies. The proportion rose to 56 percent during 1952-56 and then declined to 39 percent in 1961-64. In addition to the decline in the relative importance of molasses imports, the sources of these imports have shifted materially. Before 1960, Cuba supplied as much as 50 percent of our annual molasses imports. The quantity decreased after 1960, and since the 1962 embargo on Cuban imports, Mexico, Jamaica, Peru, British Guiana, Mauritius, the Republic of South Africa, and the Philippines have become our main supply sources. Since 1956, U.S. industrial molasses production has grown consistently and since 1960 the rate has accelerated. This expansion has paralleled the increase in sugar production in the mainland cane and beet areas.

High or low industrial molasses prices have little if any effect on molasses production, but changes in the price of sugar have a marked influence on molasses production as well as sugar production. Consumption of molasses, on the other hand, is significantly dependent upon the price of molasses. The prices for available substitutes determine the limits above which molasses prices cannot go for any extended period without causing users to shift to other raw materials. Such shifts reduce the quantity of molasses demanded and tend to lower its price. The ceiling, however, is somewhat indefinite because of the inconvenience and cost of shifting from molasses to other raw materials and the possibility of wanting to reverse the shifts in a comparatively short time.

The total quantity of industrial molasses used in the United States has increased since 1948 at an average annual rate of nearly 13 million gallons. Use of molasses in livestock feed has grown somewhat faster, averaging nearly 20 million gallons annually. Since World War II the mixed feed industry has become the most important user of molasses, as the production of ethyl alcohol from molasses has declined. The most rapid increase in molasses use has been in the preparation of pharmaceuticals and miscellaneous products, although these uses are less significant in terms of quantity.

MARKETING INDUSTRIAL MOLASSES IN THE UNITED STATES

By

L. C. Larkin, Agricultural Economist
Marketing Economics Division
Economic Research Service

INTRODUCTION

Industrial molasses (molasses used for other purposes than human consumption) is an agricultural raw material whose production is of growing importance in the United States. The quantities used both for livestock feed and in the manufacture of a number of industrial products have increased at a fairly steady rate since the end of World War II.

Recent changes in domestic and foreign sources of supply, together with shifts in utilization, have introduced new problems in the marketing of industrial molasses. Prices sometimes fluctuate widely, resulting in irregular returns to producers and causing difficulties for users who may find molasses an uneconomical ingredient of their products when prices are high. Variations in quality, particularly of imported molasses, have adversely affected the operations of certain users.

The trade recognizes six principal types of industrial molasses. A seventh type--wood molasses--presently is of little commercial importance.

1. Blackstrap molasses is produced as a joint product with sugar in mills which process sugarcane. Blackstrap molasses is a heavy, viscous liquid from which no further sugar can be crystallized by the usual methods. Its sugar content averages slightly above 50 percent. According to the Cane Sugar Handbook, "A typical analysis of cane blackstrap molasses cannot be formulated, but certain general figures are of interest. The broad range of molasses as it comes from the centrifugals would be 85 to 92 Brix (45-48° Baume) or about 77 to 84 percent solids by drying. The sucrose varies between 25 and 40 percent and the reducing sugars [such as dextrose and levulose] from 35 to 12 percent, with the sum of the two (total sugars) 50 percent or more. Immature canes, such as are encountered in subtropical countries, generally yield molasses with lower sucrose and higher reducing sugars than that of the fully matured cane of the tropics." 1/

2. Beet molasses is produced by processors of sugarbeets. It is a joint product with sugar and beet pulp. Its sugar content is about the same as that of blackstrap but it contains from 6 to 10 percent protein, compared with almost none for cane molasses. Less beet molasses than blackstrap molasses is used in the United States, but the quantity is much larger than that of any of the other types.

1/ G. P. Meade. Cane Sugar Handbook. 9th ed.; John Wiley and Sons, N.Y., 1963; p. 269.

3. Refiners' blackstrap molasses is produced in relatively small amounts when raw sugar is converted into refined form in cane sugar refineries. Its composition is not greatly different from that of the blackstrap molasses produced in processing sugarcane.

4. High-test or invert molasses is obtained from sugarcane juice from which no sugar has been extracted. It is not a joint product as are other types of industrial molasses. It has been produced only in a few countries and in certain years, usually when the world price of sugar was unusually low.

5. Hydrol (corn molasses) is produced by the corn wet milling industry as a joint product with crystallized dextrose. Its composition is similar to that of blackstrap molasses, although the sugar content may average slightly higher.

6. Citrus molasses is prepared by concentrating otherwise waste materials produced by the citrus processing industry. It contains somewhat less sugar than blackstrap but is similar in other respects.

7. Wood molasses (holocellulose molasses) is a relatively new product obtained by the treatment of otherwise waste wood products. Only one company is known to produce it and only small quantities appear to have been marketed, usually on an experimental or trial basis.

The analysis in this report is confined primarily to molasses produced from sugarbeets and sugarcane.

The purposes of the report are (1) to identify and evaluate trends in marketing practices and in the utilization of various types of industrial molasses; (2) to describe the nature and economic implications of the changing competitive positions of industrial molasses and its principal substitutes; and (3) to analyze the effects of recent changes in industrial molasses supply sources on marketing practices.

The information on which the report is based was obtained from interviews with representative producers, distributors, and users of industrial molasses, and from various secondary sources. Data cover the years 1948-65.

WORLD MOLASSES PRODUCTION AND TRADE

The production of molasses in the world increased about 70 percent from 1950/51-1954/55 through 1964/65 (table 1). The largest production throughout this period was in North America, although the relative increase in output was greater in most other areas. As a consequence of this slower growth, the North American share of world molasses production declined from 39 percent in 1950/51-1954/55 to 29 percent in 1964/65. Production increased most rapidly in the U.S.S.R. and in Asia.

Apparently about one-fifth of the world's production of industrial molasses enters international trade, although data are available only for the major trading nations. Most of the world trade consists of blackstrap produced in mills which process sugarcane. The largest volume of exports, half or more of the world total, comes from the Caribbean area. In most years Cuba has been the largest exporter, followed by other Caribbean Island producers and Mexico. On the other side of the world, Indonesia and the Philippines also regularly export sizable quantities of molasses. France is the largest exporter of beet molasses, but these exports are

Table 1.--World molasses production, 1950/51 through 1964/65 1/

Area	Average 1950/51-1954/55	Average 1955/56-1959/60	1960/61	1961/62	1962/63	1963/64	1964/65
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
United States	269	279	314	347	369	409	415
Other North America	522	494	614	499	488	500	598
Total North America	791	773	928	846	857	909	1,013
South America	272	335	426	439	411	431	466
West Europe	312	384	451	356	354	413	492
East Europe	145	157	213	222	211	240	270
U.S.S.R.	148	242	308	409	330	329	400
Africa	101	130	141	155	185	191	184
Asia	226	358	494	457	423	482	575
Oceania	51	61	54	58	76	71	84
World	2,046	2,440	3,015	2,942	2,847	3,066	3,484

1/ Includes beet molasses, blackstrap, refiners' blackstrap, hydrol, and citrus molasses.

much smaller than exports of blackstrap molasses from Cuba, Mexico, and a number of other nations.

In some countries where sugar is produced in small quantities, storage and transportation facilities are not available for moving molasses in ordinary trade channels. The molasses produced in these locations may be discarded or used locally in some manner outside the usual trade channels. For instance, it may be dumped into streams or used as road building material. Such production is not considered a part of the world's commercial molasses supply.

The United States is the largest importer of industrial molasses (table 2). However, its share of the total has declined from an average of about 65 percent during 1950-60 to 45 percent in 1961-64. The United Kingdom is still one of the world's largest importers of industrial molasses, although imports have declined both in volume and as a proportion of the world total. Since 1950, the imports of both the Common Market countries and Japan have increased substantially. The unusually large imports of the Common Market countries in 1963 appear to have been largely the result of reduced production in those countries because of a small 1963 sugarbeet crop.

The ending of U.S. imports of molasses from Cuba after 1960 caused a marked shift in the sources of U.S. imports (table 3). During the 13-year period 1948-60, Cuba supplied 58 percent of U.S. imports of molasses. The loss of imports from Cuba has been partially made up by increases from other countries, the most important of which is Mexico. Imports from the West Indies other than Cuba and from the Dominican Republic have also increased substantially.

Imports of beet molasses from France, the principal source of such imports, have increased about 10 million tons per year in recent years.

Table 2.--Industrial molasses; world imports, 1950-64

Year	Imports of industrial molasses by countries of entry					
	United States	United Kingdom	Common Market countries	Japan	Other countries	Total 1/
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
1950....	244	110	6	--	22	382
1951....	228	109	9	2/	29	375
1952....	296	47	5	13	33	394
1953....	411	69	11	21	34	546
1954....	341	94	16	31	36	518
1955....	378	105	18	31	44	576
1956....	352	87	13	29	54	535
1957....	231	64	24	30	54	403
1958....	334	54	21	33	62	504
1959....	282	73	35	49	71	510
1960....	450	81	45	64	79	719
1961....	260	78	49	76	69	532
1962....	264	97	82	96	47	586
1963....	270	74	115	107	57	623
1964 3/.	266	80	98	104	51	599

1/ Specified countries only, but believed to represent most of the world total.
2/ Less than 500,000 gallons. 3/ Preliminary.

Table 3.--Sources of U.S. imports of industrial molasses, 1948-65

Year	Cuba	Dominican Republic	Mexico	Other Caribbean	Philippines	Other	Total
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
1948...	139	20	33	1/	1/	13	205
1949...	162	18	24	1/	1/	11	215
1950...	187	17	21	1/	1/	19	244
1951...	130	17	25	1/	1/	56	228
1952...	187	28	22	1/	1/	59	296
1953...	291	26	32	17	1	44	411
1954...	203	24	38	18	6	51	340
1955...	233	35	43	18	13	36	378
1956...	232	32	30	16	9	33	352
1957...	117	22	40	20	5	28	232
1958...	118	25	47	22	4	118	334
1959...	90	47	62	25	6	52	282
1960...	229	62	76	38	6	39	450
1961...	12	54	71	41	7	75	260
1962...	2/	52	64	52	16	80	264
1963...	0	43	93	41	12	81	270
1964...	0	33	86	47	19	81	266
1965...	0	41	96	38	9	84	268

1/ Included in "other." 2/ Less than 500,000 gallons.

Source: Molasses Market News, Annual Summaries. U.S. Dept. Agr., Consum. and Mktg. Serv.

U.S. SUPPLY

The U.S. industrial molasses supply is composed of mainland production, shipments to the mainland from Hawaii and Puerto Rico, and imports from foreign countries. Domestic production increased about 50 percent from 1948 to 1965 (table 4). Net imports rose only 35 percent and total supply 43 percent. Nearly all of the increase in domestic production occurred after 1958, whereas imports after 1958, with the exception of 1 year, were below the 1948-58 average. The total supply of molasses for the United States increased fairly rapidly from 1948 to 1953, but has shown no upward trend since then, although fluctuating considerably from year to year.

Table 4.--Domestic and foreign supplies of industrial molasses, United States, 1948-65

Year	Domestic production 1/	Imports	Mainland exports	Net imports	U.S. supply
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
1948	232	205	8	197	429
1949	230	215	2	213	443
1950	242	244	2	242	484
1951	244	228	2	226	470
1952	244	296	1	295	539
1953	239	411	2	409	648
1954	241	340	5	335	576
1955	253	378	5	373	626
1956	239	352	1	351	590
1957	246	231	2	229	475
1958	245	334	2	332	577
1959	274	282	2	280	554
1960	275	450	3	447	722
1961	322	260	2	258	580
1962	324	264	2	262	587
1963	363	270	5	265	628
1964	379	266	4	262	641
1965	347	268	2	266	613

1/ Includes mainland production and shipments to mainland from Hawaii and Puerto Rico.

About one-half of the total increase in the production of industrial molasses in the United States since 1948 has been beet molasses and nearly one-third blackstrap produced in the mainland sugarcane area (table 5). In each case, most of the increase occurred after 1958, when the U.S. Sugar Act was amended to permit an increase in the production of sugar in the sugarbeet and mainland sugarcane areas. The production of hydrol, although relatively small, also increased considerably after 1958.

FACTORS INFLUENCING RECOVERY RATES FOR MOLASSES

Molasses produced from sugarbeets and sugarcane is of minor economic importance compared with its joint product, sugar. The proportions of sugar and molasses produced by sugarbeet and sugarcane processors are largely fixed by the

Table 5.--Supplies of industrial molasses from domestic production, United States, 1948-65

Year	Beet 1/	Mainland cane	Hawaii 2/	Puerto Rico 2/	Refiners blackstrap	Hydrol	Citrus	Total
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
1948	38	40	44	55	36	18	11	242
1949	42	44	43	59	33	19	7	247
1950	61	45	41	50	34	21	8	260
1951	46	44	45	60	33	18	12	258
1952	39	52	44	70	36	18	9	268
1953	48	49	51	60	36	19	7	270
1954	52	46	52	62	32	18	9	271
1955	52	49	51	56	33	16	8	262
1956	52	38	53	57	40	17	8	265
1957	63	43	52	53	39	16	10	276
1958	67	40	53	57	40	20	6	283
1959	77	43	57	61	40	21	8	307
1960	79	47	51	58	41	23	5	304
1961	98	60	56	62	46	23	6	351
1962	97	65	57	56	47	24	10	356
1963	125	90	55	62	48	28	5	413
1964	3/ 125	103	58	65	45	30	4	430
1965	3/ 112	3/ 86	58	57	45	27	8	393

1/ Year harvested. 2/ Total quantity produced, which is larger than shipments to continental United States. 3/ Preliminary.

Source: Molasses Market News, Annual Summaries. U.S. Dept. Agr. Consum. and Mktg. Serv.

composition of the sugarbeets and sugarcane. These proportions vary from region to region and among seasons in the same region. Production techniques may alter the relationship somewhat, but only to a minor degree. Because of these circumstances, the molasses-sugar ratio for most countries can only be approximated. Calculated averages of molasses produced per ton of sugar during the period 1955/56 through 1959/60 are shown in table 6 for the major regions of the world.

Table 6.--Production of molasses per ton of sugar produced, major producing regions of the world, 1955/56 through 1959/60

Area	Gallons of molasses per ton of sugar	Area	Gallons of molasses per ton of sugar
United States:		West Europe 3/	49.5
Cane	58.1	East Europe 3/	42.2
Beet	29.8	U.S.S.R. 3/	42.9
Other North America 1/ 2/	50.5	Africa 3/	48.1
South America 2/	57.2	Asia 2/	46.0
		Oceania 2/	37.1

1/ Except Canada. 2/ Largely cane sugar. 3/ Beet sugar.

Generally, the relationship between the quantity of molasses produced and the quantity of raw materials processed--sugarcane or sugarbeets--is closer than that between molasses and sugar. However, data showing the quantity of sugarcane or sugarbeets processed are not available for all countries, and in other cases the data appear to be less reliable than those for sugar production.

The quantity of molasses manufactured per ton of sugar produced from sugarcane is closely related to the quality of the sugarcane processed: The lower the sugar content of the sugarcane juice being processed and the higher the impurities (nonsugar solids), the larger the quantity of molasses which will be produced per unit of sugar.

The quantity of beet molasses manufactured per unit of sugar produced depends not only on the sugar content and purity of beets, but to some extent on the type of process used. The simplest process, common to all sugarbeet processing plants, yields a product known as "straight house" or whole molasses. In addition to this process some plants have "Steffins" facilities which process straight house molasses to extract part of the sugar in that molasses. The composition of Steffins molasses is not greatly different from that of straight house molasses, but considerably less molasses per ton of sugar beets processed is obtained in plants with a Steffin facility than in plants without such a facility. Straight house molasses averages approximately 5.0 percent of the weight of the beet processed as compared with 3.25 percent for the molasses processed in a Steffins plant.

The quantity of hydrol produced in the United States is primarily a function of the quantity of crystallized dextrose manufactured. The raw material for the manufacture of dextrose is starch, usually corn starch. Hydrol production per 100 pounds of dextrose manufactured averages about 2.6 gallons.

The size of the citrus crop in Florida and the proportion that is processed largely determines the quantity of citrus molasses produced. Small quantities of citrus molasses are used in the production of alcohol, but the larger proportion is mixed with dry citrus pulp and sold to local feed mixers.

High-test or invert molasses, the only type of industrial molasses which is not a joint product, is produced only occasionally and under special circumstances. Small quantities have been produced in the mainland sugarcane area from cane which was damaged by freezing so that sugar could not be produced commercially from it. However, most production has been in other countries, in years when there was more sugarcane than was needed to produce the sugar which could be marketed under governmental programs. 2/

High-test molasses is usually produced only in years of high sugar production, when the world's production of blackstrap molasses is relatively high and industrial molasses prices are low. For example, the United States imported 132 million gallons of high-test molasses from Cuba in 1954 and 232 million gallons in 1955. In 1955, the New Orleans price of industrial molasses was unusually low--10.38 cents per gallon, compared with 17.15 cents for the previous 5 years and 15.25 cents for the following 5 years. The availability of high-test molasses in 1955 may have had a depressing effect on the already low industrial molasses prices.

2/ This was not true during World War II, when the U.S. Government purchased industrial molasses for war-time purposes.

MOLASSES PRICES

Prices of industrial molasses in the United States in recent years have fluctuated much more widely than domestic prices of sugar, but to about the same degree as sugar prices in the world market (table 7). Sugar prices in the United States are influenced by the operation of the sugar quota system, which does not influence the marketing or prices of molasses. High prices for sugar in the world market, usually accompanied by high prices for molasses, have been followed by somewhat larger than usual increases in world production of sugar and molasses. The increased output of molasses following high prices is primarily in response to increased sugar prices rather than increased molasses prices.

Table 7.--Industrial molasses prices, sugar prices, and molasses and sugar production, 1955-65

Year	Molasses, price per gallon, f.o.b. tank car New Orleans	Raw sugar, price per pound		World production	
		New York duties paid	World	Molasses	Sugar, raw value
	Cents	Cents	Cents	1,000 gallons	1,000 short tons
1955	10.34	5.95	3.24	2,278	43,464
1956	17.12	6.09	3.48	2,221	45,631
1957	20.22	6.24	5.16	2,483	49,073
1958	13.77	6.27	3.50	2,731	54,542
1959	11.34	6.24	2.97	2,747	53,923
1960	10.13	6.30	3.14	3,015	60,050
1961	13.56	6.30	2.91	2,942	57,093
1962	14.11	6.45	2.98	2,847	54,895
1963	21.53	8.18	8.50	3,066	59,782
1964	12.06	6.90	5.87	3,484	71,992
1965	8.79	6.75	2.12	3,481	69,991

Molasses importer-distributors usually purchase industrial molasses by negotiation, taking the entire output or some portion of the output of one or several raw cane sugar mills in an area. In some foreign areas the molasses is offered to prospective buyers at a quoted "take it or leave it" price. This type of price setting leaves very little, if any, opportunity for negotiation.

Local distributors have paid prices in the past based upon a quoted price plus freight. Molasses prices paid by local distributors in more recent years have been based on the average delivered-molasses prices in nearby ports. Usually, a substantial proportion of Louisiana molasses is sold before the sugar processing season begins, price being based on the season's average price as determined by quotations of the Louisiana Sugar Exchange.

Domestic beet molasses is usually purchased in much the same way as cane molasses produced in the continental United States.

Reasonably satisfactory substitutes are available for molasses in each of its principal uses. The costs of using these substitute materials, relative to the cost of molasses, set an approximate ceiling on the price for which molasses can be sold. This effect appears most clearly in the feed mixing industry in years when

prices of molasses are relatively high, and feed mixers reduce the quantity they use.

MOLASSES DISTRIBUTION

All of the molasses imported into the United States and a considerable portion of domestically produced sugarbeet and cane sugar molasses is distributed to users through a small number of firms which act both as importers and distributors, usually on a national scale. These importer-distributors resell part of their molasses supply to regional or local distributors. Local distributors frequently specialize in the type of molasses they sell in each area as well as the type of purchaser they serve.

The importer-distributors usually have unloading and storage facilities in major port cities and small distribution plants at strategic points on the main U.S. waterways systems. The molasses may be distributed from seaport terminals by barge, rail car, or truck to other storage facilities and then redistributed to users. Some regional or local distributors also have port storage facilities. However, local distributors usually sell their molasses in a limited, well defined geographic area, the extent of which is determined by relative transportation costs. Local distributors operating from seaboard terminals usually make deliveries over a fan-shaped area with a radius of 150 to 200 miles. There is a certain amount of overlapping of dealer sales areas. Competition for customers is keenest in this "no-man's land," especially when there are changes in transportation charges. Occasionally, a molasses producer acts as a local distributor. For example, a considerable part of Florida's industrial molasses is distributed by a producer who handles molasses from other mills in addition to his own output. Some sugarbeet and sugarcane processors use part of their own molasses in company owned cattle feeding operations.

During the 5 years from 1961 to 1965, about 42 percent of the molasses imported into the United States entered through ports situated on the Gulf of Mexico and 38 percent through Atlantic coast ports. Most of the remaining 20 percent arrived on the Pacific coast, although small quantities entered through inland points (table 8). About one-fourth of all molasses imports were entered through New Orleans and one-fifth at New York.

The importance of New Orleans as a molasses distribution point is even greater than is indicated by the import figures because most of the blackstrap molasses produced in Louisiana also is handled by the distributors and facilities in the New Orleans area. Much of the molasses handled at New Orleans is moved up the Mississippi River and its tributaries to secondary distribution points.

The method by which a distributor moves industrial molasses from port terminal to user depends upon (1) the length of the haul; (2) the location of the customer; and (3) the customer's storage facilities and his willingness to pay for additional services. Shipment by barge and rail car costs less, but truck delivery is often preferred by users because trucks are faster and can deliver smaller lots. Also, tank trucks are insulated and can carry preheated molasses. Some users are willing to pay additional freight costs for these advantages.

Table 8.--Industrial molasses, arrivals by customs districts, average 1961-65

District	Imports
	Million gallons
Atlantic Coast:	
New York	52
Philadelphia	9
Maryland	14
Other	26
Total	101
Gulf Coast:	
New Orleans	66
Galveston	35
Other	10
Total	111
Pacific Coast:	
Los Angeles	22
Other	17
Total	39
Inland points	15
United States	266

MOLASSES UTILIZATION

Industrial molasses is used for a number of purposes, the relative importance of which has changed markedly since 1948 (table 9). The quantity used for manufacturing alcohol had declined to insignificance, while that used for most other purposes has increased.

Feed Industry

Livestock feed has been the most important outlet for industrial molasses since World War II. The proportion used for feed has increased from around one-half to three-fourths of the total used in the United States.

The livestock feed industry, scattered throughout the United States, in most instances uses the cheapest industrial molasses locally available. Of a reported 2,587 plants in 1963, 22 percent were located in the West North Central Region, 16 percent in the South Atlantic Region, and 15 percent in the East North Central Region. 3/

3/ Census of Manufactures, 1963. Industry Statistics: Prepared Animal Feeds. U.S. Bur. Census MC63(20)D, 1966.

Table 9.--Utilization of industrial molasses, United States, 1948-65

Year	Distilled spirits 1/	Yeast, citric acid & vinegar	Pharmaceutical & miscellaneous 2/	Total nonfeed	Feed 3/	Total
	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons	Million gallons
1948	149.8	51.0	8.3	209.1	220.3	429.4
1949	175.4	51.0	7.5	233.9	209.2	443.1
1950	163.0	51.0	7.0	221.0	262.6	483.6
1951	160.9	52.0	7.0	219.9	250.4	470.3
1952	169.2	53.0	7.0	229.2	310.3	539.5
1953	208.4	55.0	8.0	271.4	376.6	648.0
1954	87.8	60.0	10.0	157.8	418.8	576.6
1955	121.3	65.0	12.0	198.3	427.4	625.7
1956	111.9	70.0	14.0	195.9	394.5	590.4
1957	59.2	70.0	14.0	143.2	332.2	475.4
1958	61.7	70.0	15.0	146.7	430.3	577.0
1959	35.3	71.0	15.0	121.3	432.2	553.5
1960	69.0	74.0	37.0	180.0	541.5	721.5
1961	8.5	70.4	47.1	126.0	454.7	580.7
1962	5.7	79.8	38.7	124.2	462.2	586.4
1963	5.0	85.0	40.0	130.0	489.9	619.9
1964	6.2	90.0	47.0	143.2	491.4	634.6
1965 4/	15.1	100.0	50.0	165.1	447.7	612.8

1/ Includes molasses used in making ethyl alcohol, butyl, and acetone prior to 1959.
2/ Pharmaceutical utilization not considered prior to 1960.
3/ A residual item, calculated by subtracting molasses used industrially from total mainland supplies without considering changes in stocks.
4/ Estimated.

Source: Molasses Market News, Annual Summaries. U.S. Dept. Agr. Consum. and Mktg. Serv.

A blend of two or more types of molasses, usually beet and cane, but sometimes mixed with hydrol, is used in the manufacture of mixed feed. The proportion of each type used depends on relative prices and availability.

Some molasses is used in poultry feed, but its chief use by food manufacturers is in dairy and other cattle feeds. It is not only a source of nutrition, but has a number of other useful characteristics. It is palatable, and its use with other feeds increases the quantity and variety that livestock will eat; its use reduces the dust in feed mixing plants; and it improves the appearance and salability of feed.

The proportion of molasses used in the feed mix ranges from about 3.5 percent in pelletized feed to more than 12 percent in mash type feeds, by weight of the feed mixture. Manufacturers commonly vary the proportion from time to time as price relationships between molasses and other feed ingredients change. While other ingredients can be satisfactorily substituted for the caloric value of the sugar in molasses, suitable substitutes for the nonnutritive characteristics of molasses in mixed feeds are difficult or even impossible to find. But even in situations where it is not desirable to completely eliminate molasses from mixed feed, it is frequently

possible, when prices are high, to reduce the amount without unduly lowering the quality of the feed.

Because of its characteristic taste and odor, sugarcane molasses is preferred to other types in feeding livestock. Beet molasses and hydrol are usually blended with cane molasses for this reason. The maximum proportion of molasses usable in a feed mixture tends to be determined by its effect upon the hardness of the finished product, which in turn depends upon the type of grain and other ingredients used. Bran will absorb about one-third of its weight in molasses, and oats between one-fourth and one-third. Most grains, however, are only coated with molasses, and if too much is used, the feed hardens and becomes unusable.

One reason for the use of molasses in certain feeds is to make them more attractive to feeders. Apparently some buyers like to be able to see, smell, and feel the molasses in the various feeds, and believe that if the feed appears attractive to them, the cattle will like it.

The production of pelletized feeds and crumble feeds has increased considerably since 1960. Instead of approximately 12 percent molasses as in conventional mash type feeds, pellets and crumble feeds contain only 3 to 7 percent molasses. At these lower levels of molasses requirements, pellets and crumbles are generally highly palatable to animals, and dust problems in the mixing plants are not serious. In times when molasses prices are high, the smaller amount used in the pelletized and crumbled feeds is especially important.

In addition to pelletizing feeds, feed mixers in recent years have experimented with the use of molasses concentrates and flavorings and with the use of various animal tallows and greases. Neither appears to have been very successful as molasses substitutes. The molasses flavorings and concentrates are evidently too expensive to compete with molasses.

A few sugarcane and sugarbeet processors use part of the molasses they produce in their own cattle feeding operations. Some of these processors fatten cattle in feedlots, imcorporating the molasses in mixed feeds as is done in commercial feed mixing operations. Others use part of their molasses as a supplemental feed for cattle on pasture and sell some of it locally to farmers for livestock feed. However, the quantity sold in this way is relatively unimportant.

Yeast, Citric Acid, and Vinegar

In 1965, 100 million gallons of industrial molasses were used in the production of yeast, citric acid, and vinegar. More molasses is used in yeast than in the other products in the group. In some years this has amounted to as much as half the total for the group.

Yeast

Yeast producers are located in three general areas of the United States: on the eastern seaboard, in the Midwest extending from St. Louis to Milwaukee, and on the Pacific coast. East and west coast yeast producers primarily use imported cane molasses, although some beet molasses is imported from Europe and some may be shipped in from producing areas in Michigan and Ohio. In the Midwest and Far West, beet molasses is less expensive thanonthe east coast, primarily because

of differences in transportation charges. This situation encourages yeast producers in those areas to use a larger proportion of beet molasses than on the east coast.

A mixture of 70 percent beet and 30 percent cane molasses is generally considered to be the most desirable for yeast manufacture from the technical standpoint, although many other combinations are used depending upon other factors. The higher protein content of beet molasses is advantageous as it enables producers to obtain a larger yield of yeast per gallon of molasses. Sugarcane molasses gives yeast manufacturers less trouble from acidity or sulphur dioxide. A blend of the two types of molasses enables producers to get the highest yield of high quality yeast.

The molasses blend used varies with a number of factors such as plant location, transportation charges, and availability and prices of supplies. Yeast manufacturers located at or near east coast seaports have been able to obtain imported beet molasses in recent years at prices considerably below those prevailing for domestically produced beet molasses.

High molasses prices in some years have stimulated interest in the use of substitute materials, dextrose being most frequently considered. However, some yeast producers consider dextrose too expensive and lacking in some of the ingredients needed to produce a satisfactory yield of high quality yeast.

Citric Acid

Citric acid is usually produced by a fermentation process, with beet or cane molasses commonly used as the principal raw material. Industrial capacity in 1964 was about 144 million pounds. 4/ Production is estimated to have been 70 million pounds in 1960 and 90 million in 1964.

Citric acid is used in food products as a flavor enhancer, as a preservative, as an antioxidant, and as a regulator of acidity in jellies and beverages. It is used in electroplating, metal cleaning, rust removal, leather tanning, and bottle washing; as a component in floor cements, linoleum, and ink removers; and in the production of cigarette papers and pharmaceuticals. It is also used in the petroleum industry.

Citric acid is produced in plants located in New England and the Midwest. New England producers use imported mill run cane molasses. Manufacturers in the Middle West formerly used high-test cane molasses and whatever other types were available. Producers generally would prefer a molasses of relatively high sugar content and uniform quality, but in recent years high-test molasses has either not been available at all or has been available only at prices that would make its use uneconomic. Most of that sold in the United States before 1960 came from Cuba.

Some producers of citric acid report that the shift from Cuba to a number of other countries as sources of blackstrap molasses has created problems for them. Because of the variable quality of molasses coming from different sources, it has been necessary to continuously adjust plant operations, and this has generally resulted in lower yields and higher processing costs. These difficulties have encouraged the use of substitute materials, primarily dextrose, particularly in areas where molasses costs are relatively high because of high transportation costs.

4/ Chemical Economic Handbook. Stanford Res. Inst., Menlo Park, Calif., 1965.

Dextrose of uniform quality, suitable for the production of citric acid, can be manufactured from corn starch.

Vinegar

Production of vinegar from molasses is combined with production of vinegars from cider in data published by the Bureau of the Census. The 1963 Census of Manufactures indicates that 70 million gallons of vinegar were produced in 1963, with an estimated value of $828 million, but no data are available on what proportion was made with molasses. Some shift is occurring away from molasses to other products as raw materials used in the production of vinegar.

Pharmaceutical Preparations

A small but growing amount of industrial molasses is used by the pharmaceutical industry in various fermentation processes in the production of vitamins and organic acids, and as a coating agent. The quantity used for these and similar purposes increased from 8 million gallons in 1948 to 50 million gallons in 1965.

Molasses used in most pharmaceutical preparations is subject to the same type of competition as molasses used for other purposes. However, the growing market for pharmaceuticals suggests that the industry's use of molasses will continue to increase.

Alcohol

The production of ethyl alcohol from petroleum gases (ethyl sulfate and ethylene) increased rapidly in the United States after World War II. New processes have made it possible to produce alcohol more cheaply from petroleum gases than from molasses, except in years when molasses prices are unusually low. The use of molasses at such times is possible because some molasses using plants have been kept for use under favorable price circumstances. In 1930, less than 1 percent of the ethyl alcohol produced in the United States was manufactured from petroleum gases, while in 1960 more than 90 percent was produced from these materials.

Estimated materials costs for producing a gallon of alcohol from ethylene and from industrial molasses indicate that molasses is competitive only at considerably less than 10 cents per gallon (table 10). In most years since 1948, ethylene has been much the cheaper raw material. Even in 1960, when the price of molasses was unusually low, molasses was slightly more expensive than ethylene. An additional advantage of ethylene is that its price has been much more stable than that of molasses.

Molasses used in the production of distilled spirits in 1965 totaled 15 million gallons. This was more than twice as much as in 1964 and the most used for this purpose since 1960. However, in 1965 blackstrap molasses prices averaged almost 4 cents per gallon less than in 1964 and were the lowest since 1948.

Blackstrap molasses is the only type of industrial molasses used extensively for alcohol production. Beet molasses is usually more valuable for other uses, such as yeast production. Except for small quantities of citrus molasses in Florida, neither citrus molasses nor hydrol has ever been available in sufficient supply to be attractive to industrial alcohol distillers, and neither is technically as well suited to the fermentation process as is blackstrap.

Table 10.--Ethylene and molasses: Unit prices and costs of quantities used per gallon of ethyl alcohol, 1948-65

Year	Prices		Cost of material per gallon of alcohol	
	Ethylene, per pound	Molasses, per gallon	Ethylene 1/	Molasses 2/
	Cents	Cents	Cents	Cents
1948	6.0	19.80	27.0	47.5
1949	4.5	9.60	20.0	24.0
1950	4.3	14.88	19.3	37.2
1951	4.2	32.19	19.0	80.5
1952	5.7	18.38	26.0	46.0
1953	5.0	10.72	22.5	26.8
1954	4.7	10.38	21.1	25.9
1955	4.7	10.34	21.1	25.8
1956	5.0	17.12	22.5	42.8
1957	4.7	24.22	21.1	61.0
1958	4.7	13.77	21.1	34.4
1959	5.0	11.34	22.5	28.3
1960	5.0	10.13	22.5	25.3
1961	5.0	13.56	22.5	33.9
1962	4.7	14.11	21.1	35.3
1963	4.5	21.53	20.0	53.8
1964	4.7	12.06	21.1	30.1
1965	N.A.	8.79	--	21.9

1/ Assumed yield of 1 gallon of ethyl alcohol from 4.5 pounds of ethylene.
2/ Assumed yield of 1 gallon of ethyl alcohol from 2.5 gallons of molasses.

Sources: U.S. Tariff Commission, Synthetic Organic Chemicals, published annually; and Molasses Market News, Annual Summaries. U.S. Dept. Agr. Consum. and Mktg. Serv.

Future Trends

Continued growth in the use of industrial molasses in the United States appears to depend primarily upon its expanding use in the mixed feed industry and in chemical production other than the manufacture of ethyl alcohol. Increased use in the production of pharmaceuticals seems likely, unless a cheaper source of raw materials for fermentation becomes available. Since 1960, the use of molasses by the pharmaceutical industry has increased at an average rate of about 7 percent per year. Another important growth use for industrial molasses is in the production of yeast and citric acid. The growth rate for these products in recent years has paralleled that for pharmaceuticals. The demand for yeast in particular is rising.

Dextrose recently has replaced molasses as a raw material in some citric acid production. This practice may spread. However, the price-cost relationship between the various types of raw material varies with the geographic location of producers and such a shift may not be advantageous to all producers.

The trend toward crumble and pelletized feeds may reduce molasses consumption somewhat, as the development of pelletized feeds appears to have been encouraged by increasing molasses prices. But this trend may be partly offset by recent developments in the production and use of dried molasses. About 5 percent of the molasses used in livestock feed is dried molasses. Most of this is manufactured in the Midwest.

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