Brown Oil Extractor

A new commercial method for the production of citrus essential oils in Florida

J. W. Kesterson, R. J. Braddock, and P. G. Crandall
University of Florida, Institute of Food and Agricultural Sciences, Agricultural Research and Education Center, Lake Alfred, FL

Citrus peel oils have been manufactured in Florida by seven different types of equipment: Pipkin roll, screw press, Fraser-Brace excoriator, FMC rotary juice extractor, FMC citrus juice extractor, AMC scarifier, and Brown peel shaver.[4] In 1975, the Brown Oil Extractor (BOE),[a] a new commercial apparatus for the recovery of citrus essential oils, was installed for the first time in Florida.[1,2] During the past 4 years, the BOE has replaced some Brown peel shaver, screw press, and FMC citrus juice extractor installations for the production of citrus oils.

The BOE is unique in that the extraction of the oil is accomplished on the whole fruit before the juice is removed. In so doing, the loss of oil during the juice extraction process is avoided and the maximum oil recovery is obtained.[1,5] Citrus fruits are caused to spin in the bight or trough between adjacent parallel rolls. Each roll is formed of a plurality of axially spaced metal discs, each disc having pointed teeth on its periphery. The pairs of rolls operate within a receptacle in which water covers the rolls so that the fruit are partially submerged during the oil extraction operation. The rolls all turn in the same direction with alternate rolls turning faster. The fruit is moved from one trough to the next by means of a conveyor-driven Geneva movement which advances the fruit intermittently through the equipment. The oil is removed in the form of an emulsion which is separated by standard centrifugation procedures.

Experimental samples

A total of 35 commercial samples of early season (Hamlin), midseason (Pineapple), and late season (Valencia) orange oils were collected during the 1976, 1977, and 1978 processing seasons from four different citrus processing plants utilizing the BOE for oil recovery. Orange oil lots ranged from 3,266 to 90,718 kg representing a total of 928,503 kg.

Fifteen white grapefruit (Duncan and Marsh) oils were also collected during the 1976, 1977, and 1978 processing seasons from three different commercial processors utilizing the BOE for oil recovery. Lots of grapefruit oil ranged from 1,814 to 13,608 kg and represented a total of 48,081 kg.

Orange oil samples were analyzed in accordance with the analytical procedures of the United States Pharmacopoeia XIX (USP)[6] and the grapefruit oils were analyzed in accordance with the analytical procedures of the Essential Oil Association of America (EOA).[3]

Discussion of results

The physical and chemical properties for four commercial samples of Hamlin orange (early-season), 14 samples of Pineapple orange (midseason), 17 samples of Valencia orange (late-season), and 15 samples of Duncan and Marsh (white grapefruit) oil produced during three different processing seasons using the BOE are shown in Table 1. These data show that the orange oils met all the specifications of the USP except that for evaporation residue. It is apparent that fruit variety has an influence on evaporation residue values. Weighted average values for evaporation residue were below the USP minimum of 43 mg/3 ml for both early-season and Valencia orange oils; whereas, Pineapple orange oils exceeded the USP minimum.

The evaporation residue value serves little value in confirming adulteration or establishing the purity of any citrus oil, be it orange, grapefruit, tangerine, lemon, or lime. Evaporation residue values are influenced by many variables that have no relationship to purity, but do have an influence on the physicochemical properties of the oil. Some of these variables are: fruit vari-

[a] Brown International Corp., Covina, CA

 0361-8587/79/0004-0901$02.00—

Table 1--Maximum, minimum and average values for the properties of coldpressed citrus oils produced by the Brown Oil Extractor during the 1976, 1977 and 1978 processing seasons

Method of extraction	Brown Oil Extractor											
Fruit variety	Hamlin orange			Pineapple orange			Valencia orange			White grapefruit[1]		
No. of samples	4			14			17			15		
Quantity oil--kg	185,519			357,431			385,554			48,081		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Sp. gravity 25°C/25°C	0.8436	0.8430	0.8434	0.8448	0.8427	0.8436	0.8452	0.8429	0.8438	0.8579	0.8530	0.8549
Ref. ind. N_D^{20}	1.4731	1.4725	1.4728	1.4737	1.4726	1.4729	1.4730	1.4725	1.4728	1.4782	1.4764	1.4769
Ref. ind. 10% dist. N_D^{20}	1.4717	1.4716	1.4717	1.4721	1.4714	1.4717	1.4718	1.4715	1.4716	1.4719	1.4693	1.4713
Difference	0.0014	0.0008	0.0012	0.0016	0.0010	0.0012	0.0013	0.0011	0.0012	0.0071	0.0049	0.0055
Opt. rot. α_D^{25}	+98.05	+97.18	+97.66	+98.15	+96.88	+97.50	+97.80	+96.74	+97.21	+92.62	+90.37	+91.87
Opt. rot. 10% dist. α_D^{25}	+98.82	+97.86	+98.36	+98.73	+97.94	+98.22	+98.42	+97.63	+97.98	+98.21	+96.88	+97.25
Difference	+ 0.77	+ 0.50	+ 0.70	+ 1.39	+ 0.25	+ 0.72	+ 1.31	+ 0.04	+ 0.77	+ 7.15	+ 5.03	+ 5.38
Aldehyde content--%	1.39	1.31	1.35	1.63	1.19	1.38	1.89	1.58	1.75	1.49	1.17	1.34
Evap. res. (mg/3 ml)	42.6	37.7	40.8	56.8	34.2	45.4	44.7	36.0	40.9	8.39%	6.57%	7.26%
Ultraviolet spectrum:												
1. CD	0.916	0.442	0.698	0.636	0.387	0.479	0.777	0.541	0.623	0.578	0.410	0.459
1. Max. abs. (Peak)	1.288	0.638	0.992	0.942	0.600	0.741	1.102	0.829	0.903	0.682	0.466	0.561
1. mμ	330.0	324.0	327.0	330.0	328.0	329.1	330.0	327.0	328.3	320.0	319.0	319.7
2. CD	--	--	--	--	--	--	--	--	--	0.062	0.035	0.041
2. Max. abs. (Peak)	--	--	--	--	--	--	--	--	--	0.365	0.149	0.270
2. mμ	--	--	--	--	--	--	--	--	--	269.0	267.0	268.2

[1]White grapefruit oils not de-waxed.

ety, fruit maturity, cultural practices, seasonal or climatic differences, budwood, rootstock, geographical location, method of oil recovery, and oil yield. A more complete discussion of the variables listed above has been published.[4]

The one factor that probably has the greatest influence on evaporation residue is the yield of oil recovered from the fruit by any given oil recovery process.[4] The higher the yield the greater the evaporation residue. The next most important factor is the method used to extract the oil from the fruit. Methods that allow the oil from ruptured oil glands to come in intimate contact with the surface of the fruit and dissolve natural waxes will give an oil with a higher evaporation residue. Since the BOE removes the oil under water, the oil has limited opportunity to come into contact with the surface of the fruit. Consequently, low evaporation residue values will be inherent to this method of oil recovery.

The grapefruit oils met all the specifications of the EOA except that for specific gravity (0.846 to 0.852). All lots of oil exceeded the maximum of 0.852, with an average weighted value of 0.854. None of the grapefruit oils was thoroughly de-waxed prior to analysis which accounts for the high specific gravity values. Thorough de-waxing of grapefruit oil will normally lower the specific gravity units by 0.002 to 0.004, which should bring the grapefruit oils into grade. By thorough de-waxing and blending, grapefruit oils produced by the BOE should meet all of the requirements of the EOA specifications.

Most commercial methods utilize large volumes of water for oil recovery (11.4-30.3 liter/40.8 kg box fruit). The BOE requires low volumes of water for oil recovery (1.9 liter/40.8 kg box fruit). Since the oil emulsions are extremely low in soluble and insoluble solids, the centrifuge ring dam water is capable of being recycled back into the process almost continuously. In present day citrus processing technology, this factor is most important because less centrifuge capacity is required to handle the oil emulsions, and the load going to the waste disposal plant is greatly reduced. The low volume of water coupled with the low soluble and insoluble solids in the oil emulsions are factors which tend to promote the optimum recovery of citrus essential oils with a high aldehyde content.[4]

These studies have demonstrated that the BOE is capable of producing orange and grapefruit oils that have excellent color, flavor, and aroma. Oils produced commercially by the BOE have been readily accepted by the essential oil industry.

References

1. R. C. Bushman, U.S. Pat. 3,707,176, Dec. 26, 1972
2. R. C. Bushman and F. K. Holbrook, U.S. Pat. 4,070,959, Jan. 31, 1978
3. Essential Oil Association of USA Specifications and standards, New York, 1965
4. J. W. Kesterson, R. Hendrickson, and R. J. Braddock, Florida citrus oils, Tech. Bull. 749, Univ. Fla. Agric. Exp. Stn., Gainesville, FL, 180 p., 1971
5. P. E. Shaw, Citrus essential oils, Perf. Flavorist **36**, 35-40 (1979)
6. United States Pharmacopoeia, XIX revision, 824 p. Mack Publishing Co., Easton, PA, 1975