a similar film of tung oil. A thin film of *Garcia nutans* oil, exposed to the air, but not to the sun, required more than a week to dry. The dry film has the wrinkled surface characteristic of oils than contain acids having a conjugated system of double bonds. It appears probable that the oil contains substances that effectively retard polymerization or oxidation of the oil. Such substances would also retard gel formation in the Browne heat test.

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Moisture Determinations on Tung Fruit and Its Components for Control Purposes

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Because the many control analyses required in connection with milling of tung oil in the South are costly and time consuming it is important to simplify procedures and equipment as much as possible and yet have methods that will yield reliable results.

The moisture content of material delivered and processed at the oil mill is of interest to the tung fruit grower and miller from a number of standpoints and any method which provides such information promptly is of considerable value to them. For example, tung fruits frequently are purchased at the mill by weight. Since there is a direct relation between the moisture content and oil content of tung fruit, a rapid method of determining the moisture content at the mill, and thereby affording information for promptly computing the value of each load, benefits both the seller and the buyer.

A method for moisture content described by McKinney and Freeman** required the heating of the components of tung fruits in a drying oven at 101-102°C. for a 24 hour period, but a simpler, quicker method for use at tung mills not provided with complete laboratory equipment seems desirable. It was found that several commercial devices were adequate for such determinations. The common feature of these devices is the blowing of a large volume of air over a heating element and thence through a vessel containing the sample. The vessels are of metal, and the bottoms are closed with metal filter cloths, which pass air very freely. Temperature control is effected generally by thermostats or rheostats. An outstanding feature of the devices is the short heating period required, which occasions a minimum of decomposition during drying.

With one such device it was found that the moisture content could usually be obtained after heating the sample at 260°F. for 10 to 15 minutes. This particular device is composed of a blower and a thermostatically controlled element, so arranged that hot air can be blown through the sample, which is held in a pan 5¼ inches in diameter, 2 inches deep, and having a 500-mesh filter-cloth bottom. An electric interval-timing switch controls the heating period. It is essential, however, that the air blast be brought to the desired temperature before the determination is started. This is done, of course, by operating the heater and blower for several minutes before introduction of the sample. A long-stem thermometer, calibrated in degrees F. is mounted in the cone immediately over the sample pan to give the temperature of the air blast.

After grinding, the sample is weighed directly in the special pan, which has been previously tared, and the pan is placed in the drier for the required time. At the conclusion of the drying period the pan is transferred to a dessicator, in which it is allowed to remain over calcium chloride until the pan and contents have cooled sufficiently for weighing. The weight and percentage loss can then be determined. The percentage loss in weight is recorded as the moisture content.

In order to determine the temperature and time required for drying, materials were heated in this device at several temperatures, weights being taken at various intervals of time to observe progressive weight losses. Check determinations were made by heating a sample from the same lot under a vacuum of 28-29 inches of mercury at 110°C. for 4½ hours. The materials were prepared by grinding each component of the tung fruits twice in a Russwin food chopper, No. 1 type, using a sixteen-tooth cutter. The data obtained for ground tung kernels are given in Table I.

Due to the tendency of the tung oil to undergo oxidation and polymerization, these data indicate that, while the moisture content of tung kernels may be ascertained by drying for five minutes, the drying period at such a temperature and for kernels of such a moisture condition cannot be extended appreciably without increase of sample weight due to oxidation.

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** McKinney, R. S., and Freeman, A. F., Oil and Soap *16*, 151-2 (1939).

TABLE I

Ground Tung Kernels

Time	Temp.	Sample Wt.	Wt. Loss	Moisture (% Loss)	Moisture (% Loss Vac. Oven)
0 min.	166°F.	47.0 g.	.....	....	....
1 min.	166°F.	46.3 g.	0.7 g	1.5	....
5 min.	166°F.	45.8 g.	1.2 g.	2.6	....
10 min.	166°F.	45.7 g.	1.3 g.	2.8	....
15 min.	166°F.	45.7 g.	1.3 g.	2.8	3.6
0 min.	216°F.	47.0 g.	.....	....	....
1 min.	216°F.	45.8 g.	1.2 g.	2.6	....
5 min.	216°F.	45.4 g.	1.6 g.	3.4	....
10 min.	216°F.	45.3 g.	1.7 g.	3.6	....
15 min.	216°F.	45.3 g.	1.7 g.	3.6	3.6
0 min.	260°F.	47.0 g.	.....	....	....
1 min.	260°F.	45.5 g.	1.5 g.	3.2	....
5 min.	260°F.	45.3 g.	1.7 g.	3.6	....
10 min.	260°F.	45.5 g.	1.5 g.	3.2	....
15 min.	260°F.	45.7 g.	1.3 g.	2.8	3.6

On the basis of the data in Table I a number of samples of ground tung kernels were dried in the moisture tester at 260°F. for 5 minutes, a check being made in each instance by drying a like sample under vacuum as described. The data obtained are given in Table II.

TABLE II

Ground Tung Kernels

Sample No.	Percent Moisture	
	Moisture Testing Device*	Vacuum Oven**
1.	3.4	3.4
2.	3.5	3.5
3.	2.8	2.9
4.	4.7	4.5
5.	3.2	3.0
6.	3.4	3.5
7.	2.9	2.9

* 260°F.—5 min. ** 110°C.—4½ hrs.

A sample of meal, representative of material fed to expeller presses, was taken from a tung oil mill for testing. Such material was composed of approximately 75 per cent kernels and 25 per cent shells. Samples of the seeds of tung fruit, which are composed of kernel and shell, were also tested in the special drying device. Check determinations were made in a vacuum oven, the data being given in Table III.

TABLE III

Meal for Expeller Pressing

Sample No.	Percent Moisture	
	Moisture Testing Device 260°F.—10 min.	Vacuum Oven 110°C.—4½ hrs.
1.	11.8	12.0
2.	11.7	12.0
3.	11.8	12.0
4.	.....	11.8
Average	11.8	11.95

Ground Tung Seeds

Time	Temp.	Sample Wt.	Wt. Loss	(% Loss) Moisture	Moisture (% Loss Vac. Oven)
0 min.	260°F.	47.3 g.	.....	.....	.....
5 min.	260°F.	37.1 g.	10.2 g.	21.8	.....
10 min.	260°F.	36.7 g.	10.6 g.	22.4	.....
15 min.	260°F.	36.7 g.	10.6 g.	22.4	22.0
0 min.	260°F.	47.1 g.	.....	.....	.....
5 min.	260°F.	34.7 g.	12.4 g.	26.3	.....
10 min.	260°F.	34.3 g.	12.8 g.	27.2	.....
15 min.	260°F.	34.3 g.	12.8 g.	27.2	.....
20 min.	260°F.	34.3 g.	12.8 g.	27.2	.....

In order to study the use of the special drying device in the determination of moisture in whole tung fruits, the fruits were ground twice in the Russwin chopper, and 50-gram portions were tested. When no further weight loss was observed in several runs, samples were transferred to the vacuum oven and heated for 4½ hours at 110°C. In each instance the sample increased slightly in weight, probably due to oxidation; consequently, it may be assumed that the value obtained in the special drying device was fairly close to the true moisture value, and that is sufficiently accurate for control purposes. The data obtained are given in Table IV.

TABLE IV

Ground Whole Fruits

Time	Temp.	Sample Wt.	Wt. Loss	Moisture (% Loss)
0 min.	260°F.	47.1 g.	.....	.....
5 min.	260°F.	29.0 g.	18.1 g.	38.4
10 min.	260°F.	28.9 g.	18.2 g.	38.7
15 min.	260°F.	28.7 g.	18.4 g.	39.0
20 min.	260°F.	28.7 g.	18.4 g.	39.0
25 min.	260°F.	28.7 g.	18.4 g.	39.0
0 min.	260°F.	47.3 g.	.....	.....
10 min.	260°F.	35.9 g.	.....	.....
15 min.	260°F.	35.9 g.	11.4 g.	24.1
Sample placed in vacuum oven:				
4½ hrs.	110°C.	36.1 g.	11.2 g.	23.7
0 min.	260°F.	53.9 g.	.....	.....
10 min.	260°F.	41.2 g.	12.7 g.	23.6
15 min.	260°F.	41.2 g.	12.7 g.	23.6
Sample placed in vacuum oven:				
4½ hrs.	110°C.	41.4 g.	12.5 g.	23.2
0 min.	260°F.	50.0 g.	.....	.....
10 min.	260°F.	41.0 g.	9.0 g.	18.0
15 min.	260°F.	41.0 g.	9.0 g.	18.0
Sample placed in vacuum oven:				
4½ hrs.	110°C.	41.3 g.	8.7 g.	17.4

Samples of tung hulls are ground twice in the food chopper and dried in the special drier. The data obtained are set forth in Table V.

TABLE V

Ground Tung Hulls

Time	Temp.	Sample Wt.	Wt. Loss	Moisture (% Loss)	Moisture (% Loss Vac. Oven)
0 min.	260°F.	53.9 g.	.....	.....	.....
5 min.	260°F.	36.9 g.	17.0 g.	31.5	.....
10 min.	260°F.	36.6 g.	17.3 g.	32.1	.....
15 min.	260°F.	36.6 g.	17.3 g.	32.1	31.9
0 min.	260°F.	53.7 g.	.....	.....	.....
5 min.	260°F.	25.3 g.	28.4 g.	52.8	.....
10 min.	260°F.	25.2 g.	28.5 g.	53.1	.....
15 min.	260°F.	25.1 g.	28.6 g.	53.3	53.3

While the times of drying at 260°F.—5 minutes for tung kernels, 15 minutes for hulls, 10 minutes for seeds, 10 minutes for expeller meal, and 15 minutes for whole fruits—are satisfactory for materials having approximately the same character and moisture contents, the moisture content of tung fruit and its components will vary considerably due to conditions at the time of harvesting and storage, as well as the manner in which the fruits are stored. In routine determinations with the special moisture testing device, it therefore will be necessary for the analyst to determine from time to time the best period of drying by a few trial runs.