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WATER ACTIVITY IN RELATION TO THE SIZE OF BLACK TEA PARTICLES

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Determinations of moisture content and water activity made on eight different size groups of tea particles (0.50 to 1.68 mm) indicate that water activity is independent of the particle size. It is concluded that the shelf life of tea grades depends only on moisture content and water activity and not on particle size.

INTRODUCTION

In most homogeneous food materials the water activity is independent of the particle size, even though particle size does play a considerable part in the rate of equilibration (Taylor, 1961). In dried black tea dhools the particles are polydispersed (de Silva, 1972). The behaviour of water activity in relation to particle size of teas is not known. It is however noted that some physical and chemical characteristics of black tea vary with particle size and therefore variation in water activity may as well be expected.

In this investigation ungraded tea dhools (exclusive of Big Bulk) were separated into different particle size groups and the behaviour of water activity in relation to the moisture content was studied.

MATERIALS AND METHODS

The laboratory instrument used to measure the equilibrium relative humidity in this investigation was the Rotronic - Hydroskop DT. The instrument and the method adopted for measurement of water activity are similar to those described by Thevathasan and Samaraweera (1985).

Partially dried tea dhool samples were taken from the Fluid Bed Drier (FBD) and separated into eight different particle size groups by the method adopted by de Silva (1972) using a sieve shaker fitted with a set of nine British Standards test sieves (BS 410, 1962). The particle sizes of the groups as characterized by the sieve diameters through which they were extracted (Snowsill, 1985) were 1.68, 1.40, 1,20, 1.00, 0.85, 0.71, 0.60 and 0.50 mm. The moisture content of the partially dried tea dhools collected from the FBD was around 10 per cent on a dry basis. This was to avoid clogging of the test sieves during separation of the dhools with high moisture. The separated tea dhools were oven dried at a low temperature of 60°C. Samples with moisture contents varying between 0 to 10 per cent were taken from the oven at different intervals. Nine such samples from each of the eight groups were collected. Each sample was then divided into two portions and moisture content in one and water activity measurement in the other were made. Both measurements were made on duplicate samples. The moisture measurement was done by the oven method (Thevathasan and Samaraweera, 1985) and the temperature of the samples was kept constant around 22.5°C for the water activity measurements. Though it was more desirable to first dry the samples in the oven and then sieve them, this step was not taken because of the considerable absorption of moisture during the sieving operation.

RESULTS AND DISCUSSION

The per cent moisture content oh a dry basis (M) and the corresponding water activity (A_w) for different particle size groups are given in Tables Ia and b.

TABLE Ia—*Moisture content (M) and water activity (A_w) of tea dhools. Particle sizes – 1·68, 1.40, 1.20 and 1.00 mm.*

Particle Size (mm)							
1.68		1.40		1.20		1.00	
M	A_w	*M*	A_w	*M*	A_w	*M*	A_w
6.8	0.334	6.8	0.340	7.1	0.328	7.2	0.321
6.0	0.312	6.2	0.329	5.8	0.294	6.2	0.317
5.8	0.281	5.9	0.263	5.6	0.250	5.5	0.240
3.1	0.062	5.3	0.260	5.2	0.207	4.6	0.109
1.7	0.042	4.6	0.177	4.6	0.152	4.2	0.107
1.4	0.036	4.4	0.173	2.8	0.018	4.0	0.077
1.0	0.014	3.7	0.052	1.0	0.014	1.9	0.017
0.6	0.008	1.3	0.026	0.6	0.006	0.7	0.005
0.4	0.006	0.5	0.008	0.4	0.003	0.5	0.003

TABLE 1b — *Moisture content (M) and water activity (A_w) of tea dhools Particle sizes – 0.85, 0.71, 0.60 and 0.50 mm.*

Particle size (mm)							
0.85		*0.71*		*0.60*		*0.50*	
M	A_w	*M*	A_w	*M*	A_w	*M*	A_w
9.3	0.402	9.3	0.434	9.4	0.554	8.2	0.511
6.6	0.389	6.6	0.354	7.3	0.467	7.6	0.455
4.7	0.108	4.2	0.098	6.2	0.263	7.3	0.368
3.2	0.047	3.4	0.070	3.4	0.033	6.5	0.267
1.1	0.018	2.2	0.016	2.2	0.021	3.8	0.051
0.7	0.15	1.0	0.012	1.1	0.010	2.2	0.025
0.5	0.009	0.6	0.009	1.0	0.009	1.5	0.007
0.3	0.008	0.4	0.005	0.5	0.008	0.7	0.005
0.2	0.005	0.3	0.003	0.4	0.005	0.5	0.004

A relationship between water activity and moisture content was proposed by Henderson (1952) and is given by :

$$\log_e (\log_e (1/(1-A_w)) = n \log_e M + \log_e K + \log_e T$$

Where, A_w = Water activity,

M = Moisture content (dry basis),

T = Absolute temperature of the sample and

K and n = Constants for the material.

The equation can be re-written in the form $Y = b * X + a$
Where, $Y = \log_e (\log_e (1/(1-A_w)),$

$X = \log_e M$

$b = n,$

and $a = \log_e K + \log_e T.$

An analysis of variance for regression was carried out on X and Y as shown above for the sets of data of different particle size groups. The parameters of the fitted lines and their correlations along with their particle sizes are given in Table 2.

TABLE 2 —*The parameters of the fitted lines, particle sizes of the groups and correlations.*

Particle size (mm)	*Slope (b)*	*Intercept (a)*	*Correlation(r)*
1.68	1.55	-3.98	0.9874
1.40	1.53	-3.98	0.9631
1.20	1.69	-4.40	0.9855
1.00	1.20	-3.70	0.9711
0.85	1.86	-4.75	0.9643
0.71	1.47	-4.21	0.9661
0.60	1.62	-4.37	0.9434
0.50	1.95	-4.64	0.9682

A suitable statistical analysis (Davies and Goldsmith, 1972) was carried out on these eight lines to find out whether they could be represented by a single line or whether they belong to a set of separate parallel lines or to independent skew lines. Statistically ($P \geq 0.5$) it was found that the data were best represented by a single line given by:

$$Y = 1.57X - 4.23$$

The constants K and n for the tea dhools were calculated from the common equation and given by :

$K = 4.92 \times 10^{-5}$ ($°K^{-1}$) and

$n = 1.57$

These values are in agreement with the values for tea grades given earlier Thevathasan and Samaraweera, (1985).

CONCLUSION

The fact that the relationship between water activity and moisture content of black teas of the different size groups investigated in this study could be expressed by a single equation of the same form as suggested by Henderson (1952) implies that the water activity is related to the moisture content but this relationship is independent of the particle size.

As in many other food products it is known that loss of useful character in made teas is mainly due to proliferation of micro-organisms during storage which in turn is due to the water activity of the product (Labuza, 1980 ; Schwimmer, 1980 ; Taylor and Christian, 1978 ; Troller, 1980). Although it is commonly believed that the small leaf grades (for example B.O.P.F. and Dust) are spoiled faster than the larger size leaf grades (for example B.O.P.) this study shows that this is unlikely because the water activity is independent of the particle size. Faster spoilage in smaller size teas can however be due to faster absorption of moisture in view of their larger specific surface area. As a consequence it is also likely to result in higher moisture levels in smaller size teas at any given stage in post drying operations.

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