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Sorption Isotherms Phenomene in Cured Oriental Tobacco
II. Sorption Isotherms Criterias

Aumeed Noori M. Amin
Department of Crop Science, College of Agriculture,
University of Sulaimany, Kurdistan

SUMMARY

Moisture sorption isotherms in term of thermodynamic aspect, and tobacco-water system were examined for oriental tobaccos. Energetic approaches were used to describe the moisture sorption behavior of tobaccos . Cured tobacco with high moisture content possesses energetic properties different from tobacco of low moisture content of the same type of leaves. Monolayer and surface area of adsorption were evaluated at several temperatures. The vapor pressure isotherm found to be consist of two phases.

INTRODUCTION

Due to the brittleness of tobacco leaf, a detectable quality deterioration and a quality loss may occur during handling (1). The amount of damages which do occur are controlled through equilibrium moisture content (EMC). Several mathematical models were examined to describe moisture sorption isotherm (MSI) properties of cured oriental tobacco (2,3,4). A survey of water activity (a_w) behavior of several cured tobacco cultivars were evaluated (5). Moisture behavior of hygroscopic material such as tobacco had been arranged into three classes, Structural in nature, dynamic in aspect, and thermodynamic in properties (6). Hygroscopic tissue-water system could be approached through thermodynamic parameters, which provide a basis for interpretation of the nature of the system. Several characteristics of sorption energetic have been tested including heat of adsorption, force of water binding, partial enthalpy, and isosteric heat of sorption (6). The amount of energy required to change the state constituent of moisture in term of latent heat could be determine by means of comparison with evaporation of free water. Thus, the latent heat ratio of a product such as tobacco and water could be determined from EMC(7).

The moisture content (MC) possess a vapor pressure (VP) which attains the equilibrium characteristics of the material and the nature of the system, expressed in terms of VP isotherms (8). Brunauer, Emmet, and Teller (BET) model provides a valid information concerning isotherms phenomena (6,9). The equation could be used to determine the surface area of adsorption. It is also useful to evaluate the monolayer moisture coverage. In addition, the BET model possesses a temperature dependence constructed into the parameter c which reflects the site energy of monolayer and of a more distant layer. Hence, net heat of adsorption could be evaluated, which may be added to the heat of liquefaction for prediction of energy in form of heat required to desorbe the monolayer.

This study examines part of the aspect of cured oriental tobacco leaves-water isotherms phenomena, in order to achieves more knowledge concerning the nature of tobacco MC and environmental condition interaction during handling and processing.

MATERIAL AND METHODS

Leaves of two oriental tobaccos (Nicotiana tabacum L.) cultivars, Gollsur, and Prelip were evaluated by stalk position for sorption criterias. The evaluation was also conducted on a uniform leaves sample of grade A (rated excellent in grade after manipulation) of Pishdar tobacco grown locally at that district. Samples were provided for testing and analyzed for adsorption and desorption properties according to (2). All examination were conducted in four replicates.

RESULTS AND DISCUSSION

Kinetics theory suggested that, a phase transition does occur in the evaporation of water from a moist object, that is, from a liquid mass to the vapor phase, and this depends on the temperature at the phase boundary and the nature of exchange system (8). Loss of water by a hygroscopic material, thus represents a change in phase which requires a great deal of energy. This conclude that the internal energy of water vapor depends not only on its sensible heat content, i.e., temperature, but also on the considerable latent heat content (7). At a constant temperature, the latent heat ratio of any product and free water could be expressed in terms of MC if EMC data are available. The latent heat of tobacco and free water vapor from the steam table could be related, with a value greater than 1.0 as shown in fig.1 and 2. It is apparent that at a high MC, 19%, tobacco leaves behaves as a wet surface. However, latent heat ratio increases tremendously in the region of low MC (fig.1 and 2). No differences were found statistically among adsorption and desorption data at both, 21 and 32°C, even though, values of adsorption were higher than desorption. At 32°C, latent heat ratio values were lower than at 21°C.

Fig. 3 and 4 represent the VP isotherms of tobacco tested at 21 and 32°C respectively. VP isotherm could be determined from equilibrium relative humidity of the samples at each MC and saturation VP of water at each specific temperature (7). As shown in the figures, when the MC of tobacco was high, the VP was also high. But, as the MC decreased, the VP decreased slightly at first, and then dropped sharply. This is an indication of the presence of two phases each with a different slope (Table 1). The first phase possesses low VP drop, and the second

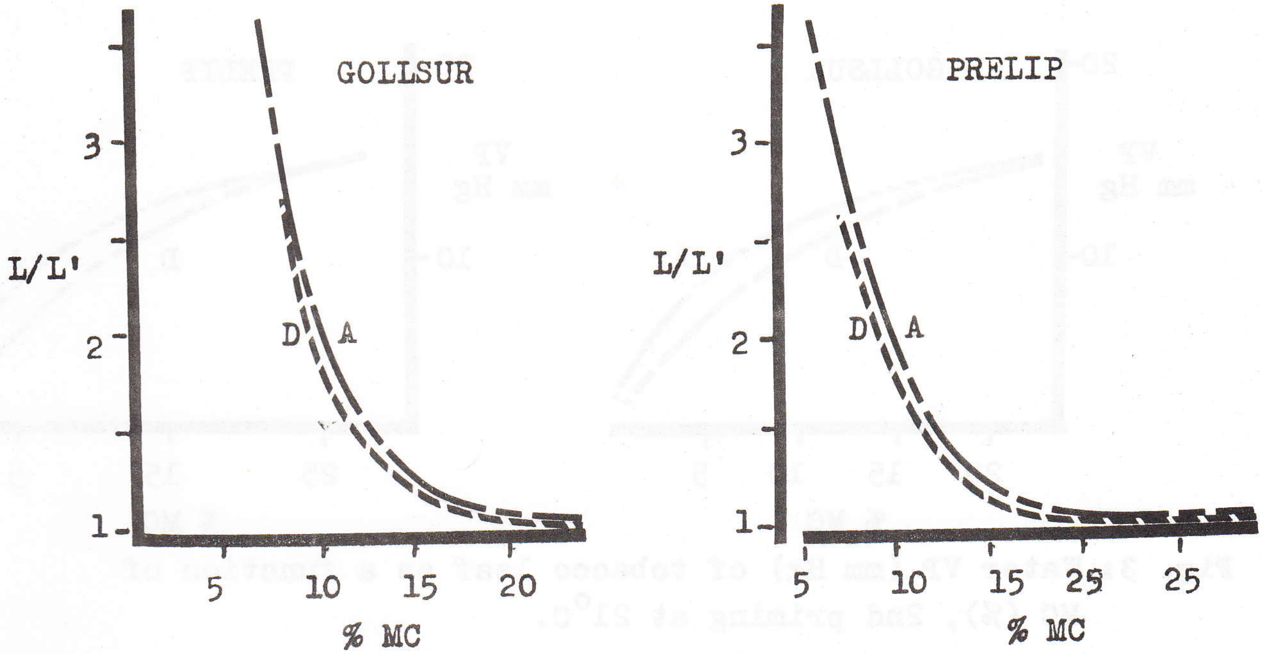

Fig. 1: The latent heat ratio for tobacco leaf as a function of MC (%), 2nd priming at 21°C.

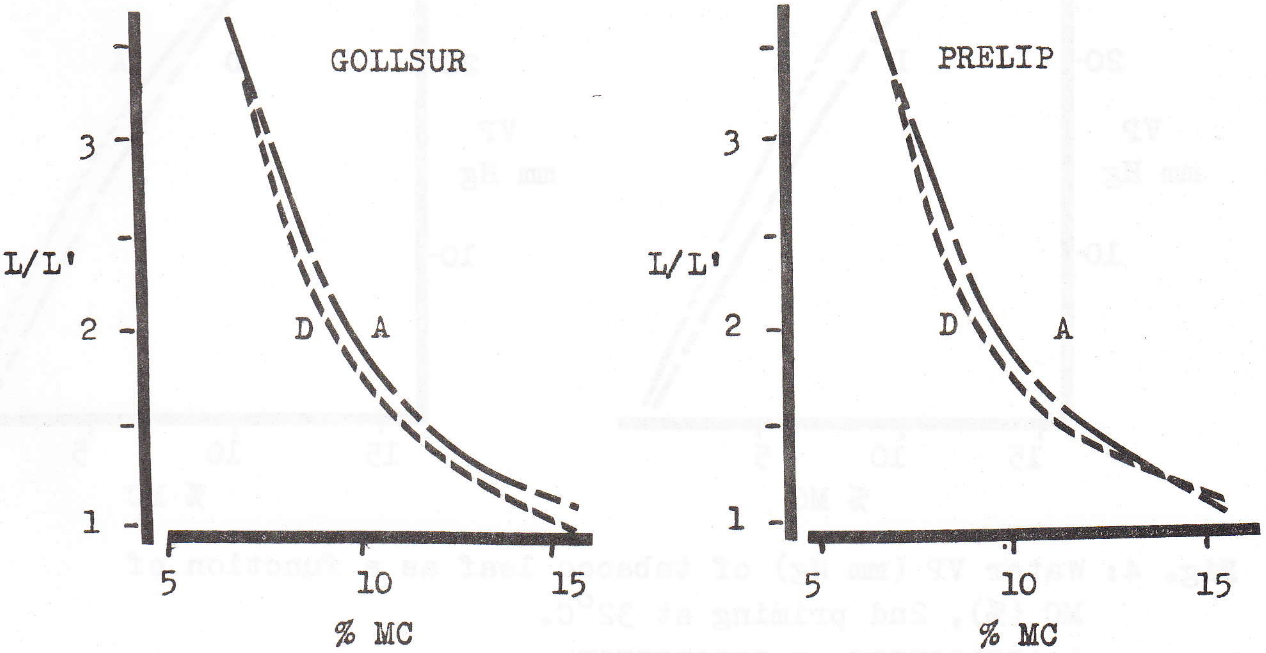

Fig. 2: The latent heat ratio for tobacco leaf as a function of MC (%), 2nd priming at 32°C.
A=ADSORPTION; D=DESORPTION.

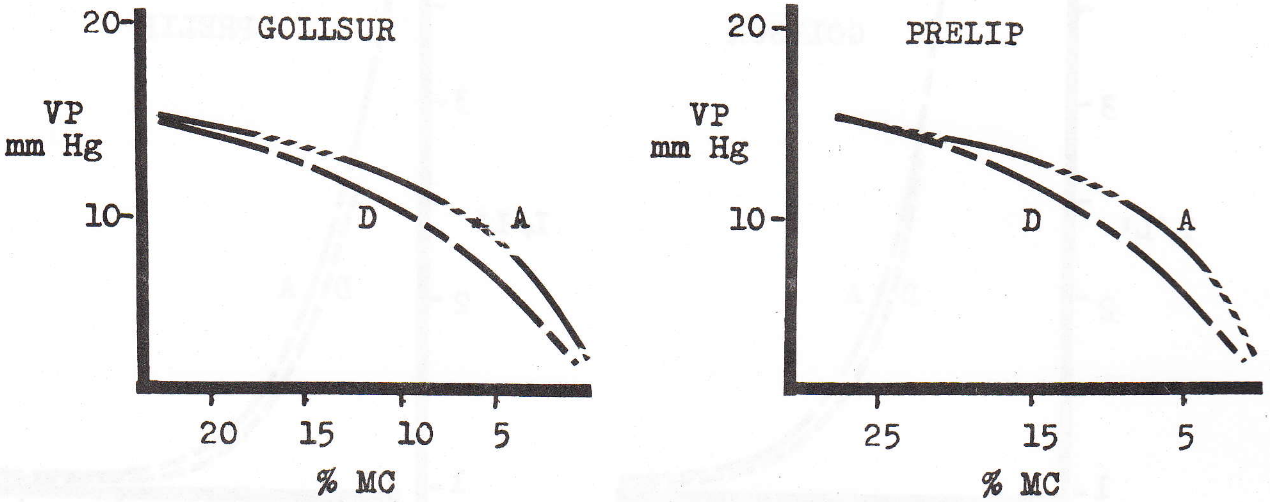

Fig. 3: Water VP (mm Hg) of tobacco leaf as a function of MC (%), 2nd priming at 21°C.

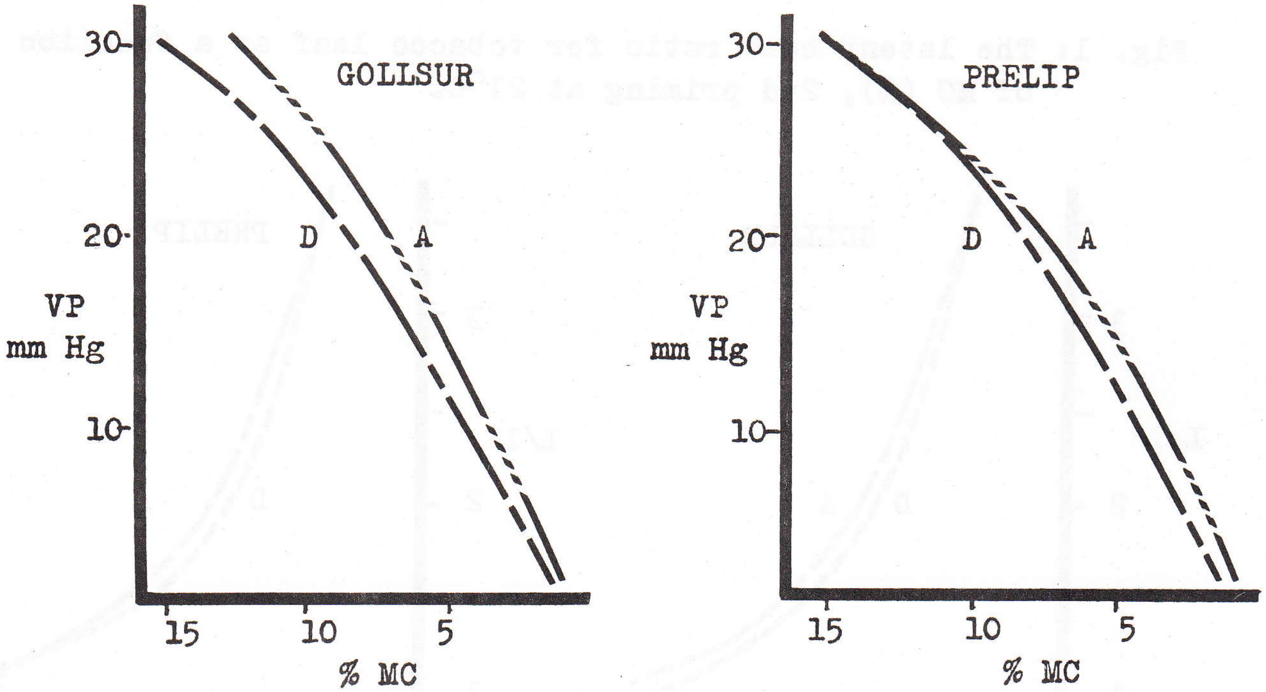

Fig. 4: Water VP (mm Hg) of tobacco leaf as a function of MC (%), 2nd priming at 32°C.
A=ADSORPTION; D=DESORPTION.

a high VP drop. It had been noticed that the junction point between the two phases at 21°C is located at 8.4-8.8 % MC for adsorption, and at 11.1-12.4 % for desorption (fig. 3, Table 1). Also, it had been observed that the VP values at the junction point for both adsorption and desorption was twice as much at 32°C in comparison with the value at 21°C. Behind the junction point, the differences will level off. Regression analysis of the two phases for adsorption and desorption, at both, 21 and 32°C of the fig. 3 and 4 are presented in table 1, which support the presence of two phases. Differences between adsorption and desorption were not present in the region above 20% MC at 21°C. The case was true for Prelip leaves at 32°C, but at the region above 11% MC. For Gollsur, the differences in VP between adsorption and desorption increased as MC increased.

Temperature dependence of isotherms could be examined in term of energetics of water-hygroscopic object system (6,9,10). The fluctuation of a_w with temperature is an expression of energy requirement as a function of moisture. On the basis of equal chemical potential for both phases of adsorbed and unadsorbed molecules of water at equilibrium, the isosteric heat (IH) could be evaluated from VP at several temperature. The Clausius-Clapeyron equation for adsorption of water in terms of IH (6,9) is describe as,

Table 1: Regression analysis and information concerning the two phases of vapor pressure isotherms for adsorption and desorption at 21 and 32°C.(at p= 0.01, df=4).

	Gollsur		Prelip	
	Adsorption	Desorption	Adorption	Desorption
First phase		21°C		
Slope, mm Hg/ MC	0.299	0.334	0.248	0.280
r	0.991	0.987	0.988	0.994
2nd phase				
Slope,mm Hg/ MC	1.008	0.835	0.916	0.736
r	0.975	0.987	0.960	0.990
Junction Point,% MC	8.4	11.1	8.8	12.4
mm Hg Vp	10.9	11.1	10.6	10.3
First phase		32°C		
Slope,mm Hg/ MC	1.587	1.316	1.189	1.180
r	0.996	0.994	0.995	0.983
2nd phase				
Slope,mm Hg/ Mc	2.906	2.453	2.545	2.577
r	0.999	0.998	0.997	0.996
Junction Point,% MC	8.6	10.2	9.4	9.8
mm Hg Vp	24.1	23.7	23.1	23.4

$d(\ln P) / d(1 / T) = - Qst / R$ ………..I
The direct integration of equation I will be,
$Qst = (R\, T_1\, T_2 / T_2 - T_1) \ln (P_2 / P_1)$ …II
Where Qst = IH; P_1 and P_2 = VP associated with temperature T_1 and T_2 respectively;
R= gas constant. Equation I could be substituted to account for pure water (6) to take the form, $d(\ln P - \ln P_w) / d(1 / T) = -(Qst - H_{H2O\ VAP}) / R$ …………..I I I
While $\ln P - \ln P_w = \ln (P / P_w) = \ln a_w$..IV
Thus, the integration of equation I I I could be written as, $a_w(T_2) = a_w(T_1) \exp(-q_{st}(1/T_2 - 1/T_1) / R)$…….V
where $q_{st} = Q_{st} - H_{H2O\ VAP}$; and $H_{H2O\ VAP}$ being the enthalpy of vaporization. Fig. 5 illustrate the IH of sorption of water on tobacco for both, adsorption and desorption (equation V). At the region extending from 17% MC and greater, no different was existed in IH of adsorption and desorption of tobacco lamina of second priming of Gollsur. At a lower MC, differences were observed. Differences increased as MC decreased. That is, at 11% MC, the difference in IH between desorption and adsorption was 3.0 Kcal mole^{-1} while at 9.0% MC this difference increased up to 4.5 Kcal mole^{-1} (Fig.5). It is apparent that in both adsorption and desorption of moisture on tobacco, the energy requirements are increases as the MC decrease, specifically in the range of 12% and lower MC.

The temperature dependent BET equation contain a c term which provides an estimate of heat of adsorption in form of minimum site energy associated with the first layer of molecules and in a more distant layer (6). This could be calculated along with a_w associated with monolayer value MC (6,9).

As it was remarked previously, the net differential heat of sorption, a_w of monolayer, and c parameter of BET model are temperature dependent. Fig.6 and 7 show the net heat of adsorption values are inversely proportional to the temperature. However, the heat of adsorption provided by BET model always underestimates the actual values (6,10). Fig.6 also reveals that the a_w of monolayer MC values are proportional to the uprise in temperature. The values of c parameter decrease as temperature of the system increases. The observed values of the constant c at different temperature may have a distinct type of behavior, in which the high values of c are allied with type I I isotherm of Brunauar, while the low values of c are linked with type I I I isotherm (6,8,11). The manner of c parameter behavior in relation to temperature is shown in fig.7. The discontinuity in the c curvature at 20°C could be postulated to be a junction point between two phases. The first represents type II isotherm associated with high c value, the second reveals type I I I isotherm related with low c value.

The monolayer MC and specific surface area were inversely correlated with temperature (Fig.8). Their values for adsorption were higher in comparison with desorption. Variation among the tobaccos examined for their monolayer MC and surface area are shown in Table II. Leaves midrib possessed a greater ability to hold MC in comparison with lamina (5). Hence, midrib characterized by having more monolayer value and greater surface area as an adsorption surface (Table II) .

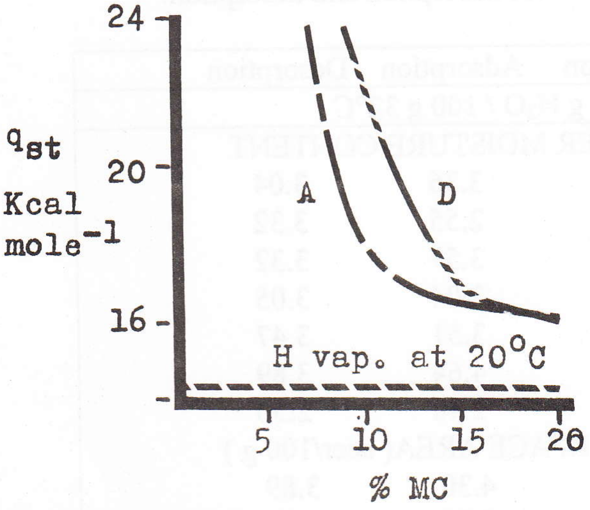

Fig. 5: Differential IH (q_{st}) versus MC (%).

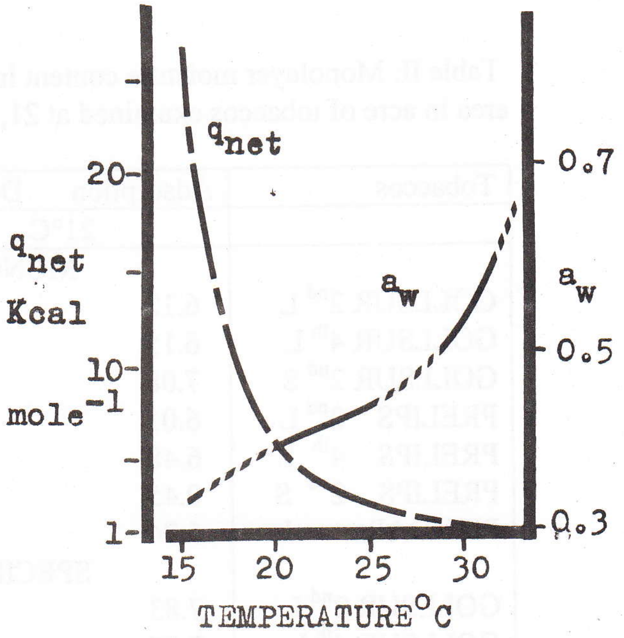

Fig. 6: Net differential heat (q_{net}), and a_w versus temperature°C.

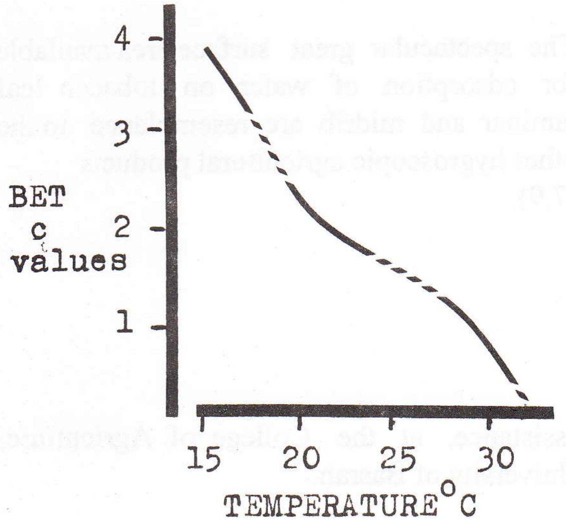

Fig. 7: Values of c constant of BET model versus temperature°C.

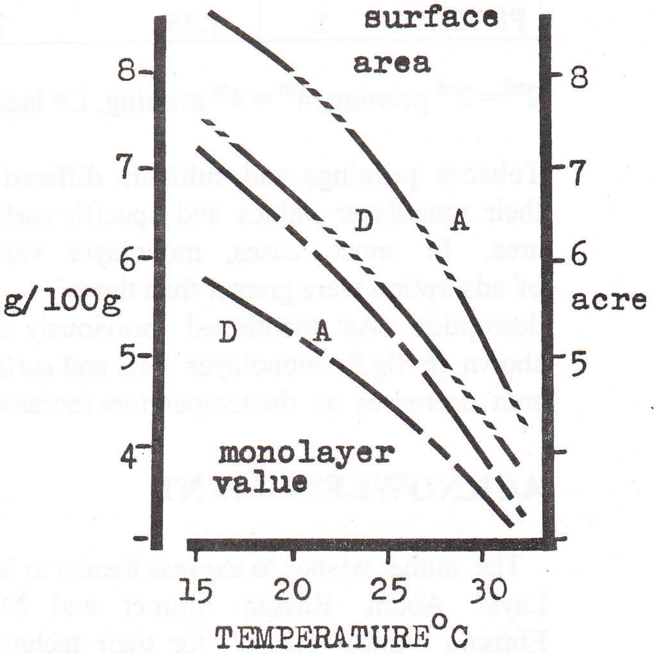

Fig. 8: Monolayer value(g/100g), and surface area(acre) versus temperature°C.

GOLLSUR leaf lamina, 2nd priming, A=ADSORPTION, D=DESORPTION.

Table II: Monolayer moisture content in g H_2O/ 100g of tobacco, and specific surface area in acre of tobaccos examined at 21, and 32°C for adsorption and desorption.

Tobaccos	Adsorption	Desorption	Adsorption	Desorption
	21°C		g H_2O / 100 g 32°C	
	MONOLAYER MOISTURE CONTENT			
GOLLSUR 2nd L	6.12	5.15	3.36	3.04
GOLLSUR 4th L	6.15	5.96	2.55	3.32
GOLLSUR 2nd S	7.08	7.19	3.57	3.32
PRELIPS 2nd L	6.01	6.32	3.04	3.05
PRELIPS 4th L	6.48	5.99	3.51	3.47
PRELIPS 2nd S	9.45	9.78	4.64	3.89
PISHDAR L	5.74	5.52	2.48	2.56
	SPECIFIC SURFACE AREA(acer/100 g)			
GOLLSUR 2nd L	7.83	6.59	4.30	3.89
GOLLSUR 4th L	7.87	7.63	3.26	4.25
GOLLSUR 2nd S	8.81	9.20	4.57	4.25
PRELIP 2nd L	7.69	8.09	3.89	3.90
PRELIP 4th L	8.29	7.67	4.49	4.42
PRELIP 2nd S	12.09	12.52	5.94	4.98
PISHDAR L	7.35	7.06	3.17	3.28

2nd = 2nd priming, 4th = 4th priming, L= lamina, S=stem.

Tobacco primings and cultivars differed in their monolayer values and specific surface area. In most cases, monolayer values of adsorption were greater than those of desorption. As mentioned previously and shown in fig.8, monolayer MC and surface area decreases as the temperature increased.

The spectacular great surface area available for adsorption of water on tobacco leaf laminar and midrib are resemblance to the other hygroscopic agricultural products (7,9).

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دیاردەی هێڵی چەماوەی هاوگەرمی مژینی شێ لە تووتنی رۆژهەڵاتی وشکراو

٢. تایبەتێکانی هێڵی چەماوەی هاوگەرمی مژینی شێ

ئومێد نوری محمد امین
بەشی بەرووبوومی کێڵگەیی – کۆلیجی کشت وکاڵ
زانکۆی سلێمانی

کورتە

تاقیکردنەوەیەک جێ بەجێ کرا لە بابەت هێڵی چەماوەی هاوگەرمی مژینی شێ بە ڕاددەی گەرمی گۆڕزانی و دەستەی تووتن– ئاو بۆ تووتنی رۆژهەلات. نزیککەوتنەوەی ووزە بەکارهێنرا بۆ پیاهەلدەدانی رەفتاری مژینی شێ لە تووتندا.

تووتنی وشککراو شێی خۆگرتنی بەرز تایبەتێکانی نزیککەوتنەوەی ووزە جیاوازە لەهەمان جۆرە تووتن کە شێی خۆگرتنی نزمە. چین یەک لەگەل رووبەری رووی روو تاقی کرایەوە لە پلەی گەرمایی جیاواز. دەرکەوت کە هێڵی چەماوەی هاوگەرمی پەستانی هەلمی لە دوو دۆخ پێک دێت....

ظاهرة المنحنيات الحرارية للامتزاز الرطوبي في التبوغ الشرقية المجففة

٢.خواص المنحنيات الحرارية للامتزاز الرطوبي

ئوميد نورى محمد امين
قسم المحاصيل الحقلية – كلية الزراعة – جامعة السليمانية

الخلاصة

تم اختبار المنحنيات الحرارية للامتزاز الرطوبي بمفهوم الداينميكية الحرارية ونظام التبغ – ماء وذلك للتبوغ الشرقية. استعملت معايير الطاقة لشرح سلوك الامتزاز الرطوبى للتبوغ. وُجد ان التبوغ المجففة ذات المحتوى الرطوبى العالى لها خواص في معايير الطاقة تختلف عن نفس التبوغ فى حالة احتوائها على رطوبة واطئة. ثم تقييم الطبقة الاحادية والمساحة السطحية للادمصاص عند درجات حرارة مختلفة.ظهر بان المنحنيات الحرارية للضغط البخارى تتكون من طورين.