KOREAN J. FOOD SCI. TECHNOL.
Vol. 22, No. 5, pp. 530~532 (1990)

Effect of Cooking on Moisture Sorption Properties of Corn

Mario Carranza and Sung-Kon Kim
Department of Food Science and Nutrition, Dankook University, Seoul

Abstract

The moisture sorption behaviors of dry corn(DC), dry-cooked corn(DCC) and soaked-cooked corn(SCC) at 25°C were analyzed. The corn was soaked in water at 26°C for 8 hr. The cooking times for DCC and SCC were 30 and 20 min, respectively, at 80°C. Desorption occurred for DC and DCC at RH below 23% and SCC at RH below 33% during storage. Moldiness was observed in all samples at RH 97%, after 192 hr for DC and 288 hr for both DCC and SCC. At the same water activity, SCC sample had the highest moisture content, followed by DC. The SCC sample had the highest monolayer value and sorption heat. Stability isotherms indicated that DC and SCC had better storability than DCC.

Key words: corn, sorption isotherm, stability isotherm

Introduction

In south and Central American countries, including Peru, corn is usually cooked and dried to prolong the shelf-life. Cooked and dried kernels are very hard and vitrous. Two important preservative changes can be considered as a result of cooking: destruction or reduction of microorganisms and inactivation of enzymes.

An important factor affecting the stability of dried foods is water activity[1], since both chemical reaction rates and microbial activity are directly controlled by water activity[2-4]. It is well known that the determination of Brunauer-Emmett-Teller (BET) monolayer[5] derived from the moisture sorption isotherm is an effective method for predicting the storage stability of dried foods. Most deteriorative reactions in food systems have the lowest rate at the BET monolayer which usually corresponds to the water activity of 0.2-0.4[6].

The sorption isotherms of corn were studied by several workers[7-12]. However, little knowledge is available for sorption isotherm of cooked corn. The purpose of this study was to determine the moisture sorption behavior of cooked corn.

Materials and Methods

Materials

Fresh yellow corn was purchased in the market, shelled, washed in water and dried at 30°C for 39 hr. The contents of protein, fat and ash were 13.02, 5.44 and 1.34% (db), respectively.

The dry corn (DC) was stored in vinyl bag at refrigerator until used.

Cooking of corn

The DC corn was soaked in distilled water at 26°C for 8 hr. The DC and soaked corns were cooked in excess water at 80±2°C for 30 and 20 min, respectively, and dried in an oven at 30°C with air flow for 39 hr.

The final moisture contents of DC, dry-cooked corn (DCC) and soaked-cooked corn (SCC) were 7.30, 6.38 and 9.05%, respectively. The contents of protein, fat and ash were respectively 12.79, 5.29 and 1.36% (db) for DCC and 12.44, 4.96 and 1.32% (db) for SCC.

Measurement of moisture sorption isotherms

The moisture sorption of corn samples was determined by the gravimetric method using saturated salt solutions[13] of relative humidity (RH) in the range of 23 to 97% at 25°C.

Approximately 5g samples in 38 mesh nylon screen bag (4.5 × 6.5 cm) were placed in desiccators containing saturated salt solutions. The changes of weight of the samples were periodically measured and the moisture content (db) was calculated.

Determination of BET monolayer value and thermodynamic parameters

The monolayer moisture content (Xm), the heat

Corresponding author: Sung-Kon Kim, Department of Food Science and Nutrition, Dankook University, San 8, Hannam-dong, Yongsan-ku, Seoul, 140-714, Korea

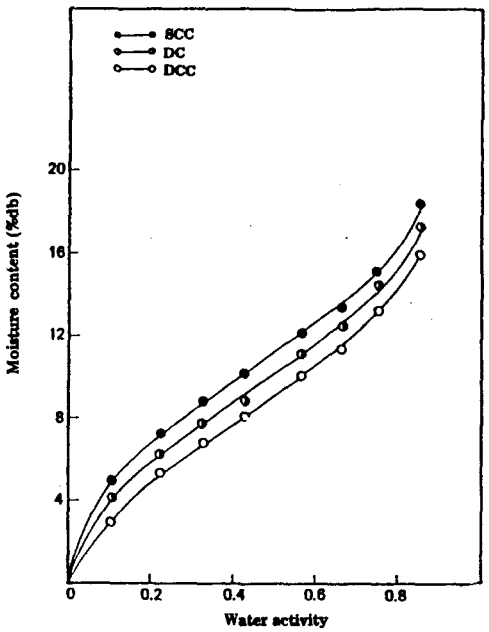

Fig. 1. Sorption isotherms of DC, DCC and SCC at 25 °C

of sorption (Qs), total heat of sorption (ΔH), free energy (ΔG) and entropy (ΔS) were calculated according to Rockland[14].

Determination of stability isotherm

The RH of optimum stability was obtained by plotting Me/RH against RH[14]. The Me is the equilibrium moisture content.

Results and Discussion

Moisture sorption data for DC, DCC and SCC indicated that desorption occurred at RH 11 and 23% for DC and DCC and at RH below 33% for SCC. This could be due to the differences in initial moisture contents and/or cooking treatments. At RH 97%, the equilibrium moisture content could not be measured because of spoilage by mold. The moldiness was observed after 192hr of storage for DC and 288hr for both DCC and SCC.

Sorption isotherm of DC, DCC and SCC at 25 °C is shown in Fig. 1. The curves were sigmoidal shape which corresponded to the type II in the classification of BET. At the same water activity, SCC sample had the highest moisture content, followed by DC.

Table 1. Thermodynamic values of BET monolayer moisture for corn samples at 25 °C

	Corn samples		
	DC	DCC	SCC
Xm(%, db)	5.53	5.73	6.29
C(constant)	19.79	20.15	23.15
Qs(kcal/mole)	1.77	1.81	1.86
ΔH(kcal/mole)	12.28	12.03	12.38
$-\Delta$G(kcal/mole)	1.01	0.97	1.05
ΔS(cal/K)	44.59	43.60	45.05

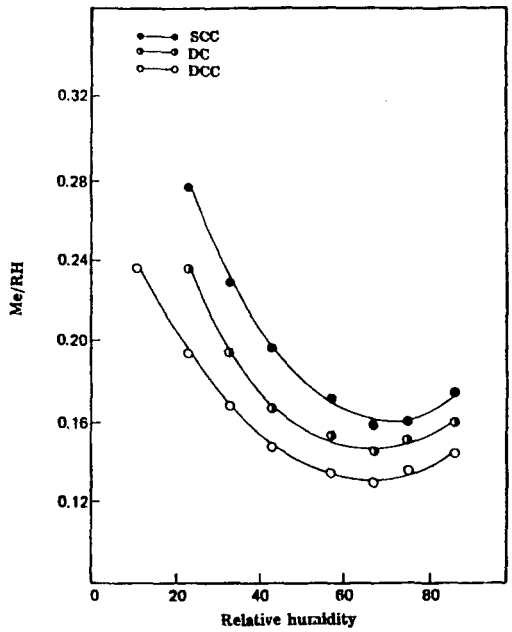

Fig. 2. Stability isotherms for DC, DCC and SCC at 25 °C

The monolayer moisture content and value for the constant C are tabulated in Table 1. The monolayer values for corn reported in the literature are 4.73% at 25 °C[9], 7.0% at 22 °C[16], 7.0%[7] and 7.3%[10] at 30 °C. The differences in monolayer values are due to the methods employed. It is known[15] that the monolayer values calculated on the desorption branch are higher than those corresponding to the adsorption one.

Thermodynamic parameters for BET monolayer values of corn samples indicated that the SCC sample had the highest values in all parameters (Table 1). In general, the Qs value changes with monolayer moisture content and shows a higher value at low

monolayer value[1,12]. However, the data in Table 1 do not show such observation.

In an isothermal process the equilibrium moisture content is a function of RH and the free energy function is minimized when Me/RH has a minimum value[14]. The stability isotherms of corn sample is shown in Fig. 2. The Me/RH values at first decreased to 60-70% and then increased thereafter. Therefore, the results in Fig. 2 indicates that the minimum changes in Me per unit change occur in RH between 60-70%. At RH 60-70%, the Me/RH values for the DC and SCC were slightly higher than that for DCC, indicating the DC and SCC have better storability than DCC.

References

1. Labuza, T.P.: Sorption phenomena in food. *Food Technol.*, **22**(3), 15 (1968)
2. Troller, J.A. and Christian, J.H.B.: *Water Activity and Food.* Academic Press Inc., New York, p. 87 (1978)
3. Simatos, D. and Multon, J.L.: *Properties of Water in Foods.* Martinus Nijhoff Publishers, Dordrecht, p. 229 (1985)
4. Rockland, L.B. and Beuchat, L.R.: *Water Activity: Theory and Applications to Food.* Marcel Dekker Inc., New York and Basel, p. 27 (1987)
5. Brunauer, S., Emmett, P.H. and Teller, E.: Adsorption of gases in multi-molecular layers. *J. Am. Chem. Soc.*, **60**, 309 (1938)
6. Labuza, T.P., Kaanane, A. and Chem, J.Y.: Effect of temperature on the moisture sorption isotherms and water activity shift of two dehydrated foods. *J. Food Sci.*, **50**, 385 (1985)
7. Hubbard, J.E., Earle, F.R. and Senti, F.R.: Moisture relations in wheat and corn. *Cereal Chem.*, **34**, 422 (1957)
8. Chung, D.S. and Pfost, H.B.: Adsorption and desorption of water vapor by cereal grains and their products. *Trans. ASAE*, **10**, 549 (1967)
9. Pixton, S.W. and Warburton, S.: Moisture content/relative humidity equilibrium of some cereal grains at different temperatures. *J. Stored Prod. Res.*, **6**, 283 (1971)
10. Chen, C.S. and Clayton, J.T.: The effect of temperature on sorption isotherms of biological materials. *Trans. ASAE*, **14**, 927 (1971)
11. Gustafson, R.J. and Hall, G.E.: Equilibrium moisture content of shelled corn from 50 to 155°F. *Trans. ASAE*, **17**, 120 (1974)
12. Rhee, C. and Maeng, Y.S.: Water vapor sorption behavior of some agricultural products produced in Korea. *Korean J. Food Sci. Technol.*, **15**, 315 (1983)
13. Rockland, L.B.: Saturated salt solutions for statistic control of relative humidity between 5° and 40°C. *Anal. Chem.*, **32**, 1375 (1960)
14. Rockland, L.B.: Water activity and storage stability. *Food Technol.*, **23**, 1241 (1969)
15. Iglesias, H.A. and Chirife, J.: B.E.T. monolayer values in dehydrated foods and food components. *Lebensm. Wiss u. Technol.*, **9**, 107 (1976)
16. Ngoddy, P.O. and Bakker-Arkema, F.W.: A generalized theory of sorption phenomena in biological materials. Part 1. The isotherm equation. *Trans ASAE*, **13**, 612 (1970)

(Received May 4, 1990)

삶은 옥수수의 수분흡습성질

마리오 까란사 · 김성곤
단국대학교 식품영양학과

옥수수의 장기저장을 위한 기초연구로서 건조옥수수 또는 침지옥수수를 80℃에서 삶고 건조한 다음 이들 시료의 수분흡습성질을 저장온도 25℃, 상대습도 23-97%에서 비교하였다. 건조옥수수는 상대습도 23% 이하에서, 침지옥수수는 33% 이하에서 탈습현상을 보였고, 상대습도 97%에서 건조옥수수는 192시간 후에, 삶은 옥수수는 288시간 후에 곰팡이가 발생되었다. 동일한 수분활성도에서 침지옥수수는 가장 높은 평형수분함량을 보였다. 단분자막층 수분함량과 흡습열은 침지옥수수의 경우가 가장 높았으며, 등온안정곡선으로부터 얻은 저장안정의 상대습도는 60-70%이었다.