

## Effect of Temperature on Sorption Hysteresis of Short Grain-Rough Rice

Myung-Gon Shin<sup>†</sup>, Dong-Chul Kim, Bong-Kee Min and Hong-Sik Cheigh\*

*Korea Food Research Institute, KIST, P.O. Box 131, Cheongryang, Seoul 130-650, Korea*

*\*Dept. of Food Science and Nutrition, Pusan National University, Pusan 609-735, Korea*

### Abstract

The effect of temperature on hysteresis of rough rice grown in Korea was investigated. The maximum hysteresis effect of Chucheongbyeo paddy rice at 5°C amounted to an average 1.7% moisture content. However, their values at 25°C and 40°C averaged 1.2% and 0.7% moisture, respectively. It may be suggested that the extents of hysteresis are affected by the temperature of adsorption and desorption.

**Key words :** temperature, hysteresis, sorption isotherm, rough rice

### INTRODUCTION

Rice is hygroscopic in nature, and it gains or loses moisture when the vapor pressure of water in the surrounding space is greater or less than the vapor pressure exerted by the moisture within the grain. This equilibrium moisture content of rough rice has been previously determined by several researchers<sup>1-5</sup>. Karon and Adams<sup>3</sup> reported the hysteresis effect in moisture sorption of rough rice at 70% and 80% relative humidity. Breese<sup>5</sup> also conducted a series of tests to determine the extent of hysteresis of rough rice at 25°C over a full range of relative humidity from 10% to 90%. But, very little work has been done on the hysteresis effect of temperature<sup>6-8</sup>.

This study was undertaken to investigate the effect of temperature on hysteresis of short-grain rough rice grown in Korea.

### MATERIALS AND METHODS

Short-grain rough rice (Chucheongbyeo, variety)

was used for this experiment. The rough rice containing an initial moisture content of about 23% (wet basis) was harvested in 1989, and the sample was divided two parts the first was stored in a refrigerator at 4°C for desorption experiment; the second was dried intermittently in a ventilated oven to a determined moisture content of 7.5% for desorption experiment.

About 10g of each sample on screen baskets were suspended in one-quart wide-mouth jars containing 200ml of saturated salts solutions. Each basket was hung from a rubber stopper that closed a small hole in the jar lid. Ten different salts were chosen for this experiment that allowed for a range of relative humidities from 11% to 98% to be tested<sup>9</sup>. To avoid spoilage due to mold growth, the same treatment as done by Gustafson and Hall<sup>10</sup> was applied to the grain samples kept at relative humidities of 90% and above.

Triplicate samples for each desired relative humidity were placed into temperature-controlled rooms at 5, 25 and 40°C within a range of  $\pm 1$ °C for each room until they reached the equilibrium moisture content. Equilibrium condition was considered to have been reached when four consec-

<sup>†</sup> To whom all correspondence should be addressed

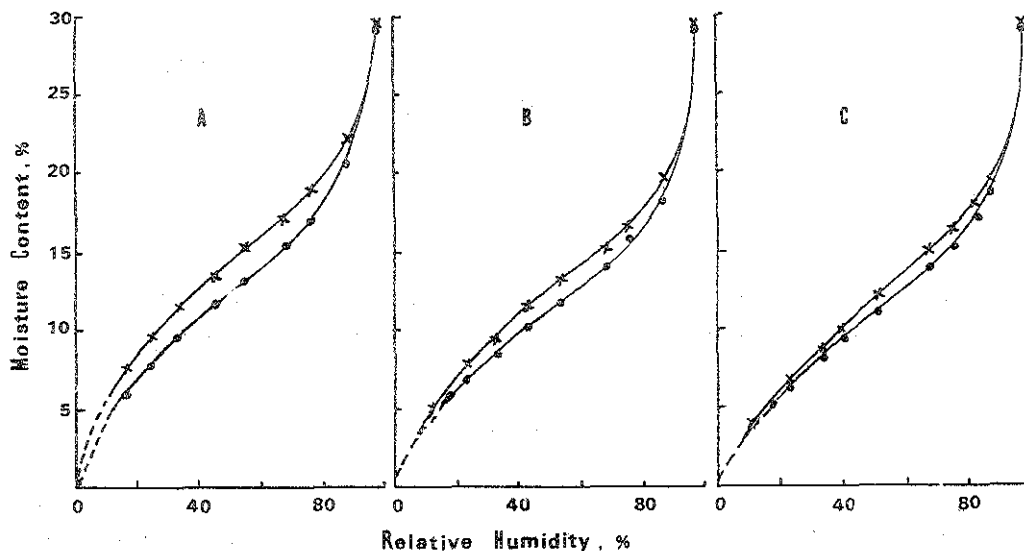


Fig. 1. Equilibrium moisture contents (dry basis) of short-grain rough rice attained by adsorption (—●—) and desorption (---×---) at relative humidities from 11 to 98% at 5°C (A), 25°C (B) and 40°C (C).

Table 1. Hysteresis extents(% of moisture content) in short-grain rough rice obtained from sorption isotherm curves at 5, 25 and 40°C

Relative humidity (%)	Temperature of sorption isotherms(°C)		
	5	25	40
15	1.4	0.2	0.1
25	1.6	0.3	0.2
35	1.7	0.8	0.3
45	1.6	1.2	0.7
55	1.8	1.3	0.8
65	1.8	1.0	0.7
75	1.4	0.8	0.6
85	1.0	0.4	0.4
95	0.2	0.1	0.1

utive measurements gave the same reading. The moisture content of the equilibrated samples was determined by the AACC method<sup>13</sup>.

## RESULTS AND DISCUSSION

The adsorption and desorption isotherms of short-grain rough rice at 5, 25 and 40°C are shown in Fig 1. Isotherms of rough rice were sigmoid and belong to the type II isotherm according to the classification of Brunauer<sup>12</sup>. Hysteresis between adsorption and desorption was also exhibited over

almost the entire range of relative humidity.

The extents of hysteresis in short-grain rough rice obtained from sorption curves (Fig. 1) are shown in Table 1. The maximum hysteresis effect of short-grain rough rice at 5°C occurred between 25% and 75% relative humidity and amounted to an average 1.7% moisture content. Above 75% relative humidity the hysteresis effect diminished gradually to less than 0.2% moisture. On the other hand, the maximum hysteresis effect at 25 and 40°C occurred between 45% and 65% relative humidity and amounted to average 1.2% and 0.7% moisture, respectively. This means that extents of hysteresis in short-grain rough rice gradually diminished with the increase of temperature. Therefore, it may be suggested that the extents of hysteresis are affected by the temperature of sorption isotherms.

## REFERENCES

1. Aquerre, R. J., Suarez, C. and Viollaz, P. E. : Moisture desorption isotherms of rough rice. *J. Food Technol.*, **18**, 345 (1983)
2. Juliano, B. O. : Hygroscopic equilibria of rough rice. *Cereal Chem.*, **41**, 191 (1964)
3. Karon, M. L. and Adams, M. E. : Hygroscopic equilibrium of rice and rice fractions. *Cereal Chem.*, **26**, 1 (1949)

4. Hogan, J. T. and Karon, M. L. : Hygroscopic equilibria of rough rice at elevated temperatures. *Agric. Food Chem.*, **3**, 855 (1955)
5. Breese, M. H. : Hysteresis in the hygroscopic equilibria of rough rice at 25°C. *Cereal Chem.*, **32**, 481 (1955)
6. Chen, C. S. and Clayton, J. T. : The effect of temperature on sorption isotherms of biological materials. *Trans. ASAE*, **14**, 927 (1971)
7. Iglesias, H. A., Chirife, J. and Ferro Fontan, C. : On the temperature dependence of isosteric heats of water sorption in dehydrated foods. , *J. Food Sci.*, **54**, 1620 (1989)
8. Aquerre, R. J., Suarez, C. and Viollaz, P. E. : The temperature dependence of isosteric heat of sorption of some cereal grains. *International J. Food Sci. Technol.*, **23**, 141 (1988)
9. Young, J. F. : Humidity control in the laboratory using salt solutions. *J. Appl. Chem.*, **17**, 241 (1967)
10. Gustafson, R. J. and Hall, G. E. : Equilibrium moisture content of shelled corn from 50 to 155°F. *Trans. ASAE*, **17**, 120 (1974)
11. A.A.C.C. : *Cereal Laboratory Methods*. 8th ed., Am. Association of Cereal Chemists, St. Paul (1983)
12. Brunauer, S. : *The adsorption of gases and vapors*, I. Physical adsorption, Princeton University Press, Princeton (1943)

(Received May 3, 1991)

## 온도가 단립종벼의 Hysteresis에 미치는 영향

신명곤 · 김동철 · 민봉기 · 최홍식\*

한국식품개발연구원 식량시스템연구실  
\*부산대학교 식품영양학과

### 요 약

단립종인 추청벼를 사용하여 온도별 hysteresis현상 변화를 조사하였다. 5°C의 경우, 상대습도 25~75% 범위에서 평균 1.7%수분함량의 최대 hysteresis현상을 보여주었으나, 25°C 및 40°C의 경우 상대습도 45~65% 범위에서 평균 1.2% 및 0.7%수분함량의 최대 hysteresis현상을 각각 나타내어, 추청벼의 hysteresis정도는 흡습 및 탈습 온도에 영향을 받고 있음을 보여주었다.