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Effect of Soluble Starch Pretreatment and Storage Condition on Caking Degree and Moisture Sorption of Powdered Onion

Myung-Hwan Kim

Dept. of Food Engineering, Dankook University, Cheonan, Chungnam 330-714, Korea

Abstract

The effects of storage temperature and relative humidity (RH), and immersion treatment (30min) of sliced onions in various soluble starch solutions(1-3%; w/v) at 25℃ before air dehydration on caking and water absorption degree of powdered onion were analyzed. In the range of 15 to 35 ℃, the caking tendency of powdered onion increased with temperature at a constant RH(70% RH). The caking degree of powdered onion also increased as increasing the storage RH, at 25 ℃. Storage RH had more influence on caking degree of powdered onion than storage temperature. Soluble starch pretreatment significantly reduced the water absorption and caking degree of powdered onion under ambient condition. A pretreatment of soluble starch solution(3%) reduced almost 80% the caking of powdered onion compared to that of control.

Key words : powdered onion, storage temperature, RH, soluble starch, caking, water absorption

INTRODUCTION

A large part of the powdered onion product is used as seasoning materials in the production of ketchup, ramyeon soup, sausage, potato chip, crackers and other snack items. Food service outlets and households also use powdered onion because of its convenience in use.

Especially in summer, many food powders may undergo physical changes during their storage or handling that result in the loss of flowability and the formation of agglomerates[1]. Powdered onions contain a relatively high concentration of water-soluble materials and are known for their hygroscopicity[2]. At low moisture content, up to about 3%, powdered onion is a typical free-flowing powder showing low compressibility, low tensile strength and low cohesion. At higher moisture content, the material becomes cohesive and may reach levels of cohesion that can not be evaluated quantitatively by methods designed for powders[3]. The moisture level in which powdered onion becomes cohesive and slow agglomeration tendency depends to a great extent on the temperature, pressure and particle size[4-6].

Steps for inhibiting caking in hygroscopic food powders are drying the powder to a low moisture content followed by storage in proper water impermeable package or below 40% RH storage, which applications are avoided for economic reasons[2]. An economically feasible method for improving the situation is the application of flow conditioners such as silicates, stearic acid salts, phosphates and starches[7]. Their main effects as flow conditioners are achieved by providing a physical barrier between the host particles thus reducing the cohesive forces and friction internally[8], cancellation of attractive electrostatic charge[9] and providing a competitive water sorption capacity[10]. But these properties are not sufficiently effective to prevent agglomeration of food powders[1].

The objectives of this study were to analyze the effect of temperature and RH of storage conditions, and soluble starch treatment before air dehydra-

tion on caking and water absorption degree of powdered onion.

MATERIALS AND METHODS

Materials

Onions (*Allium cepa*) used in this study were obtained from the 1990 harvest. The moisture content of onions was 91.07% on a wet basis. The onions were manually peeled and sliced to a 3mm thickness using a food processor (Sunbeam, Oskar).

Pretreatments

Approximately 200g onion slices were added to a 800ml soluble starch solution with different concentrations (1, 2 and 3% w/v). The immersion time and temperature were 30min and 25℃ respectively.

Dehydration

Onions on a 0.5g/㎠ tray load were directly dried in a cabinet drier at 90℃ with a 5m/s air velocity to a constant weight.

Storage

Dehydrated onions were ground to pass the 80mesh sieve and 10g of powdered onions were put in a 5cm diameter of on aluminum cup. Various levels of relative humidities (70, 80 and 90%) and temperatures (15, 25 and 35℃) were provided using a controlled temperature and humidity chamber. The storage times were 30, 60, 90, 120 and 150 min.

Determination of moisture sorption

After appropriate storage time of the sample, moisture sorption was determined using a vacuum drying oven (Yamato vacuum oven, DP-41) at 70℃ and 27 inch Hg. for 24hr.

Determination of caking degree

Caking degree of powdered onions after appropriate storage time was determined by the percentage of passed remained weight to a original sample weight after 3min of sieving using a 80mesh sieve[6]. All represented data were the means of triple replications.

RESULTS AND DISCUSSION

Effect of storage temperature on caking degree of powdered onion

The mechanism of caking of the particles, which is typical to powders that are water soluble or contain water soluble materials[11]. Especially in sugar rich materials where collapse, stickiness, flowability loss and caking problems develop as a result of transitions in the sugar states at evaluated temperature[1].

In the range of 15 to 35℃ the caking tendency of powdered onion increased with temperature increases as shown in Fig. 1, which could be expected from the behavior of other powders[4, 12]. These phenomena occurred due to the increase of water absorption and the water diffusivity within the onion particles as the temperature increased.

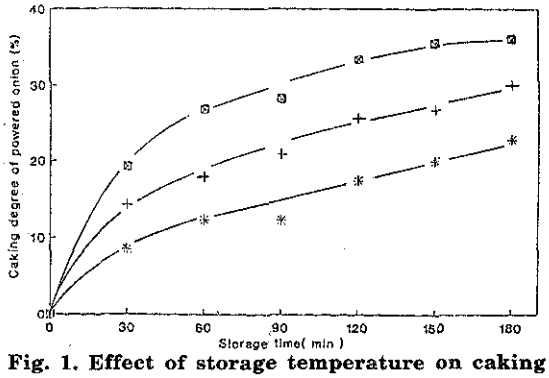

Fig. 1. Effect of storage temperature on caking degree of powdered onion at 70% RH.
⊠ 35 ℃ + 25 ℃ * 15 ℃

Effect of storage RH on caking degree of powdered onion

Below 40% RH storage, the onion powder remains free-flowing for more than six months[3]. At a high RH storage, water is absorbed on the surfaces of powdered onion particles from the atmosphere. The particles become sticky. Because the wet surfaces, with moisture being absorbed, may contain a saturated solution of the soluble components of the surface material, the solution can form liquid bridges or a continuous medium, thus attracting the particles together[3]. Another reason is that moisture absorption at high RH can result in a considerable shrinkage of onion powder which is developed by the liquid layers at the surfaces to form a closer array[5].

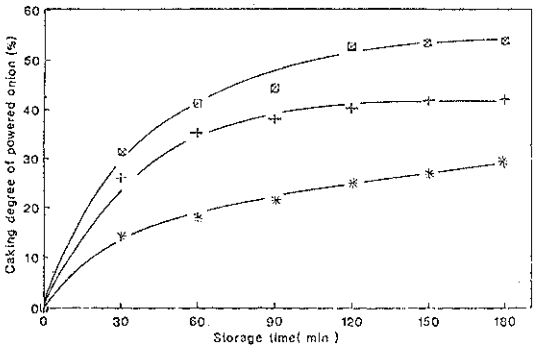

Fig. 2. Effect of storage RH on caking degree of powdered onion at 25 ℃.
⊠ 90% RH +80% RH * 70% RH

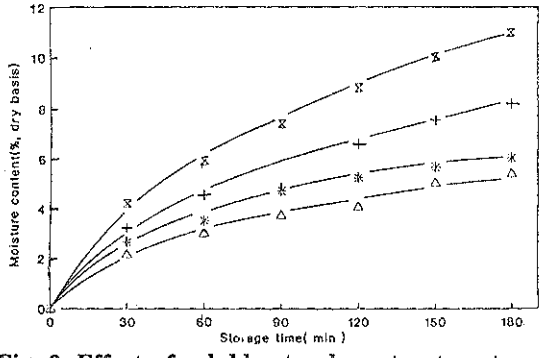

Fig. 3. Effect of soluble starch pretreatment on water absorption of powdered onion at ambient storage (25 ℃, 70% RH).
⧖ Control + 1% Starch soln.
*** 2% Starch soln. △ 3% Starch soln.**

Therefore, the caking degree of powdered onion was increased as increasing the storage RH at a constant temperature of 25℃ (Fig. 2). Storage RH had more influence on caking degree of powdered onion than storage temperature (Figs. 1 and 2).

Effect of soluble starch pretreatment on water absorption of powdered onion

Soluble starch pretreatment had significantly affected on water adsorption of powdered onions as shown in Fig. 3. As the concentration of the soluble starch solution increased, the water absorption of powdered onion decreased.

Through the 30 min of immersion in various soluble starch solution concentrations at 25℃ before air dehydration, sliced onions were coated with a layer of soluble starch and soluble starch penetrated into the sliced onions.

Therefore, pretreated onion powders using soluble starch solution competed for available water and reduced the hygroscopicity[2].

Previous researchers used to add the free conditioners in the host powders, which had no effect at all on water absorption of powdered onion with unlimited water supply[3,5,7]. Whereas, above pretreatment method significantly reduced water absorption of powdered onion during storage at ambient condition (25℃ and 70% RH).

Effect of soluble starch pretreatment of caking degree of powdered onion

Soluble starch pretreatment before air dehydration of onion decreased the caking degree of powdered onion drastically compared to control (Fig. 4). The effect on soluble starch pretreatment of caking degree of powdered onion was more affected than that on water absorption of powdered onion. At the 180 min of storage at ambient condition (25℃, 70% RH), 3% of soluble starch solution pretreat-ment reduced almost 80% of caking of powdered onion compared to that of control.

These phenomena were based on the soluble starch pretreatment which interrupted the liquid bridge between the particles of powdered onion by disrupting the liquid film continuity and acted as a lubricant by either creating a smoother surface or miniroller between the powdered onion particles during storage. The other factors were reduced the hygroscopicity as mentioned earlier, and cancellation of electrostatic charges, and reduced the molecular forces[12].

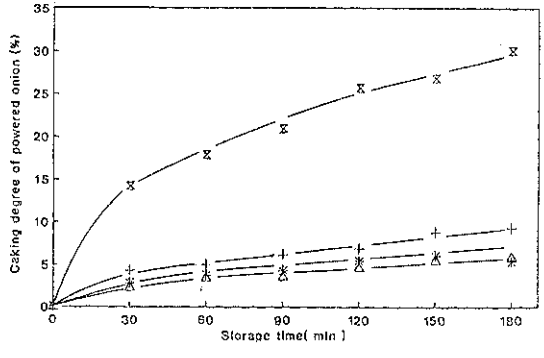

Fig. 4. Effect of soluble starch pretreatment on caking degree of powdered onion at ambient storage (25℃, 70% RH).
⧖ Control + 1% Starch soln.
*** 2% Starch soln. △ 3% Starch soln.**

REFERENCES

1. Simatos, D. and Multon, J. L. : Properties of water in foods. Martinus Nijhoff Publishers, Dordrect. p. 393 (1985)
2. Pietsch, W. B. : Adhesion and agglomeration of solids during storage flow and handling. *Trans. ASME* **5**, 435 (1969)
3. Peleg, M. and Mannheim, C. H. : The mechanism of caking of powdered onion. *J. Food Proc. Preserv.*, **1**, 3 (1977)
4. Lazar, M. E. and Morgan, A. J. : Instant apple sauce. *Food Technol.*, **20**, 179 (1966)
5. Peleg, M., Mannheim, C. H. and Passyk, N. : Flow properties of some food powders. *J. Food Sci.*, **38**, 959 (1973)
6. Malave-Lopez, J. and Peleg, M. : Mechanical attraction rate measurements in agglomerated instant coffee. *J. food. Sci.*, **51**, 687 (1986)
7. Peleg, M. and Hollenbach, A. M. : Flow conditioners and anticaking agents. *Food Technol.* **38**, 93 (1984)
8. Peleg, M. and Manngeim, C. H. : Effect of conditions on the flow properties of powdered sucrose. *Powder Technol.*, **7**, 45 (1973)
9. Nash, J. H., Leiter, G. G. and Johnson, A. P. : Effect of antiagglomerant agents on physical properties of finely divided solids. *Ind. Eng. Chem.*, **4**, 140(1965)
10. Irani, R. R., Vandersall, H. L. and Morgenthaler, W. W. : Water vapor sorption in flow conditioning and cake inhibition. *Ind. Eng. Chem.* ; **53**, 141 (1961)
11. Notter, G. K., Taylor, D. H. and Brekke, J. E. : Pineapple juice powder. *Food Technol.*, **12**, 363 (1958)
12. Rumpf, H. : The strength of granules and agglomerates. In "*Agglomeration*" Knepper, W. A. (ed)., Ind. Pub., New York (1961)

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가용성 전분의 전처리와 저장조건이 분말양파의 Caking과 수분흡수에 미치는 효과

김 명 환

단국대학교 식품공학과

요 약

저장온도 상대습도 그리고 열풍건조전 25℃에서 가용성 전분용액(1~3%;w/v)에 30분간 침지 처리가 저장시 분말양파의 caking과 수분흡수에 미치는 효과를 조사하였다. 항습조건(70% RH)에서 저장온도가 15℃에서 35℃로 올라감에 따라서 분말양파의 caking현상은 증가되었다. 항온조건(25℃)에서 저장습도가 70% RH에서 90% RH로 높아짐에 따라서 분말양파의 caking 현상 또한 증가하였다. 저장습도 증가(70~90% RH)가 저장온도증가(15~35℃)에 비하여 분말양파의 caking현상에 보다 큰 영향을 미쳤다. 가용성 전분의 전처리를 거친 분말양파는 25℃, 70℃ RH의 저장조건하에서 무처리 분말양파에 비하여 수분흡습과 caking현상을 줄일 수 있었다. 3%의 가용성 전분액에서 전처리 시킨 후 건조시킨 분말양파는 25℃와 70% RH 조건하에서 180분간 저장시킨 결과 무처리 분말양파에 비하여 약 80%의 caking 현상을 줄일 수 있었다.