THE STUDY ON THE MODIFIED STARCHES SORPTION PROPERTIES

Strilets I.
Koretska I.

National university of food technologies
Strilets I., e–mail: irina_sam@bk.ru

Summary: The study on the modified starches sorption properties is presented in the article. During the experiment the aquatic steam adsorption–desorption isotherms by modified starches at the different water activity values were got. The process of modified starches moisture absorption depending on the water activity value was considered. The possibility of using modified starches as food additives for flour confectionery storage period prolongation was analyzed.

Key words: modified starches, sorption properties, the process of dehydration.

Statement of the problem and its connection with the most important scientific and practical tasks. Even more popular becomes the extensive use of modified starches in food production. Except for providing products and semi–products with the plastic properties, modified starches that belong to the group of hydrocolloids, are able to retain some moisture, and thus extend the lifetime of the product [5, 6].

The purpose and tasks of the article. During researches of the properties of modified starches it is important to study their sorption–desorptiv characteristics. The study was carried out on a sorption and vacuum devices of Mak Ben at 20 º C temperature using the traditional methods. Water vapor was used as an adsorbtive.

Analysis of recent research and publications. Problems of extending the finished products' sale terms attracts scholarls' attention more and more. Recently, more researches are devoted to the lengthening the shelf life of food products [2, 7, 8, 9]. It is known that the dominant processes affecting the shortening of the sale terms of pastry products is the migration of moisture and products' hardening. During the development of new types of confectionery products and improving existing technologies, researchers pay particular attention to the impact of new food additives on indicators that characterize the stability of the product to deterioration.

The main material research. Water vapor isotherms of adsorption–desorption by modified and native starches are shown in Fig. 1 – 4. Charts show how the amount of adsorbed moisture (a) changes with the changing of water activity (the ratio of partial pressure of the equilibrium water vapor above the surface of the test sample to the partial pressure of saturated water vapor).

These isotherms of all investigated starches indicate thin – porous nature of adsorbents. The process of adsorption on the surface of thin – porous adsorbents has got specific characteristics and differs from adsorption on non–porous adsorbents. The pores of thin – porous adsorbents are filled with adsorbtive molecules in the area of small relative pressure, which is specially revealed for substances that are strongly adsorbed by its nature. Another feature of thin – porous systems is the presence of hysteresis rings at the adsorption isotherm, which, in our case, is accompanied at the

entire range of pressure ratio. The process of adsorption by thin – porous adsorbents is described by Polanyi theory that was improved by Dubinin Radushkevychem and BET adsorption theory [1, 3, 4].

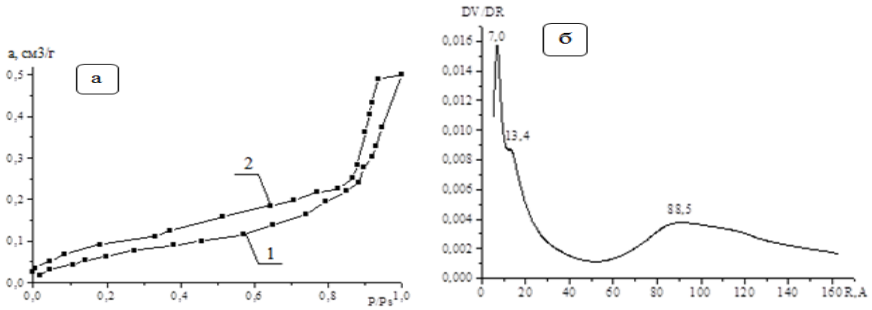

Fig. 1. Adsorption–desorption isotherms of MS «Microlys FH 02":
a) 1 – adsorption curve 2 – desorption curve; b) Differential curves of pore radius distribution

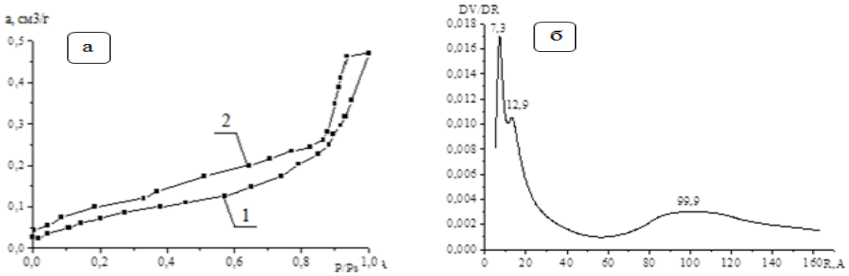

Fig. 2. Adsorption–desorption isotherms of MS «Swely Gel Soft»:
a) 1 – adsorption curve 2 – desorption curve;
b) Differential curves of pore radius distribution

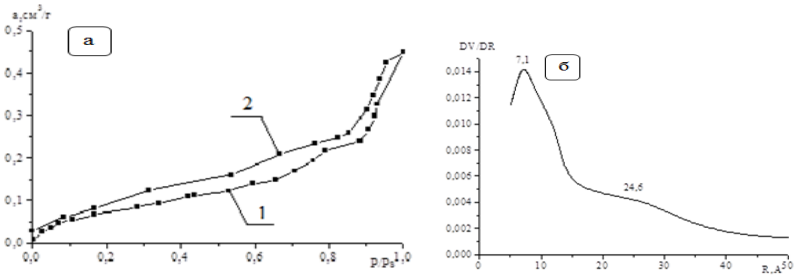

Fig. 3. Adsorption–desorption isotherms of MS «Cold Swell 5771":
a) 1 – adsorption curve 2 – desorption curve; b) Differential curves of pore radius distribution

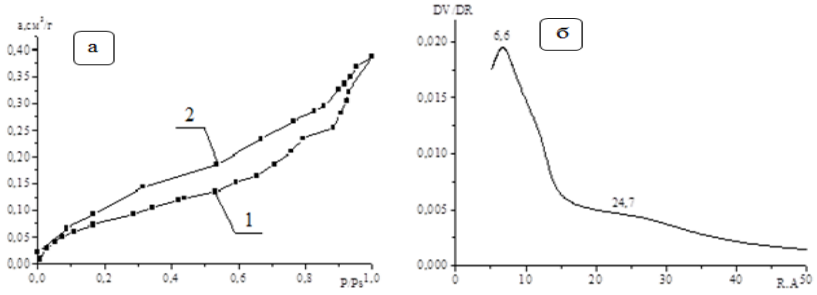

Fig. 4. Adsorption–desorption isotherms of native starch:
a) 1 – adsorption curve 2 – desorption curve;
b) Differential curves of pore radius distribution

To describe the adsorption isotherm of biopolymers adsorption, we have took the decision about conditional division into three areas depending on the value of water activity. The first area (Aw = 0 ... 0.25) – monomolecular adsorption zone; second area (Aw = 0,26 ... 0,75) – multimolecular adsorption zone; third area (Aw = 0,76 ... 1) – the zone of capillary adsorption. Calculated data on the adsorption of water in different areas of the model sample is shown below.

Table 1. *Calculated data on the adsorption of moisture*

Names of starches	The number of adsorbed moisture, cm3/g			The number of residual adsorbed moisture after desorption, cm3/g
	Area 1 Aw = 0…0,25	Area 2 Aw = 0,26…0,75	Area 3 Aw = 0,76…1	
MS «Microlys FH 02»	0,089	0,194	0,490	0,025
MS «Swely Gel Soft»	0,099	0,203	0,463	0,025
MS «Cold Swell 5771»	0,096	0,198	0,446	0,025
Native starch	0,076	0,196	0,386	0,023

In the first area of water adsorption according to Langmuir theory [1, 4], adsorption of moisture occurs not on the entire surface of the adsorbent, but only in certain areas – adsorption centers. Adsorbtive (water) is placed on the adsorbent by monomolecular layer. Number of adsorbed moisture in the first zone of the adsorption curve (a, 1) for MS «Microlys FH 02" was 0.089 cm3/g, for MS «Swely Gel Soft» – 0.099 cm3/g for MS «Cold Swell 5771" – 0.096 cm3/g. The smallest amount of adsorbed moisture (a, 1) had native starch – 0.076 cm3/g.

In the second area formation of multiple adsorption layers and expansion of the porous structure continue, as each molecule of the first adsorption layer acts as a center for the molecules that form the second layer, etc. According to the received adsorption data, in the second zone at Aw = 0.26 ... 0.75, all the studied samples adsorbed almost the same amount of moisture.

In the third zone, as the isotherms present, there is a rapid saturation by water vapor. In this area there is moisture penetration in capillary–porous structure of starches. With the value of Aw = 1 MS «Microlys FH 02" has the best ability to absorb moisture – 0.490 cm3/g. Some slightly lower indicators has got MS «Swely Gel Soft» – 0,463 cm3/g and MS «Cold Swell 5771" – 0.446 cm3/g. Native starch absorbs 0.386 cm3/g of moisture in the third zone, which is 21.22% less than in the MS «Microlys FH 02", that in this case has got the best properties.

Conclusions

When comparing desorption isotherms one should note that in all submitted samples hysteresis ring is not confined at the beginning of coordinates, that indicates the irreversibility of the process of dehydration. After desorption in all modified starches left 0,025 cm3/g of wet. In native starch, this indicator is somewhat lower – 0.023 cm3/g wet.

The results of studies of sorption properties of modified starches «Microlys FH 02», «Swely Gel Soft» and «Cold Swell 5771" showed that the selected hydrocolloids possess high adsorption capacity, herewith the largest amount of water vapor absorbs MS «Microlys FH 02" –0.490 cm3/g and desorption process is irreversible for all investigated starches.

References

1. Adamova L.V., Safronov A.P. Sorbcionniy metod issledovaniya poristoy strukturi nanomaterialov I udelnoy poverhnosti nanorazmernih system. – Ekaterinburg, 2008.
2. Dorohovich, A.N. Prodlit hranenie konditerskih izdelyi vpolne vozmojno/ A.N. Dorohovich, E.A. Gavva, V.V. Dorohovich // Hlibopekarska i konditerska promislovist Ukraini– 2012. — № 1. — С. 14–17.
3. Dubinin M.M. Adsorbciya I poristost. – M.: 1972.
4. Greg S., Sing K. Adsorbciya, udelnaya poverhnost, poristost. M.: 1984.
5. Matveeva I.V., Belavskaya I.G. Pischevie dobavki i hlebopekarnie uluchshiteli v proizvodstve muchnih izdeliy. – M.: 2001. – 116 s.
6. Philips G.O., Williams P.A. Handbook of hydrocolloids. 2nd ed. CRC Press. 2009. 1003 p.
7. Razrabotka tehnologyi sircovih pryanikov dlitelnogo hraneniya / Kirpichenkova, O., Obolkina, V., Kyianytsia, S., Kandyba, A. M. // Tehnika I tehnologiya pischevih proizvodstv : VIII Mejdunarodnaya nauchno–tehnicheskaya konferenciya, Mogilev, 27–28.04.2011 g.
8. Steele R. Understanding and Measuring the Shelf Life of Foode / Woodhead Publishing, 2004
9. Ukrainets A.I. Policukridni dobavki ta cukrozaminniki upovilnuyut cherstvinnya prianikiv / A.I. Ukrainets, A.M. Dorohovich, V.V. Fomenko, M.O. Polumbrik // Hlibopekarska i konditerska promislovist Ukraini – 2007. – № 2(27). – С. 18–19.