DOI: https://doi.org/10.53486/cike2023.12

UDC: 641.51/.54:351.778.3

WATER ACTIVITY IN CULINARY PRODUCTION

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Abstract: Water activity is a fundamental property of aqueous solutions, and by definition is the ratio of the vapor pressure of the water in the substrate to that of pure water at the same temperature.
The concept of aw has been very useful in food preservation and on that basis many processes could be successfully adapted and new products designed. Water has been called the universal solvent as it is a requirement for growth, metabolism, and support of many chemical reactions occurring in food products. Aw has its most useful application in predicting the growth of bacteria, yeasts and moulds.
The purpose of the research is to study the water activity in various culinary preparations, and to determine the influence of the thermal treatment used (frying, baking, boiling), the concentration of sugar and salt on the aw and the shelf life of the products.
The research methods used were the following: the experimental method that was carried out with the LabSwift-aw device, manufactured in Switzerland, which has a precision of 0.01 and the bibliographic research of scientific sources and the comparison of the results obtained.

Key words: water, water activity, moisture of food products, food safety

JEL Classification: L66

Introduction

The activity of water specific to a food varies according to its moisture content, so that for different foods, the same value of water activity corresponds to different humidity values. This index shows the availability of water of a product for chemical, biochemical reactions, state change or growth of microorganisms. Thus, enzymatic or nonenzymatic color changes, stability of different substances in

food (lipids, vitamins, biologically active substances and a.) depend on fluctuations in water activity values.

Water activity is an intrinsically necessary parameter in food safety and represents the ratio between the partial pressure of water vapour on the surface of the food and the partial pressure of water vapour in the ambient environment in equilibrium at the same temperature. A storage temperature change of 10 degrees Celsius causes a change in water activity from 0.03 to 0.2 depending on the type of product.

The analyzed topic is of major importance in the food industry, because it significantly influences the organoleptic qualities, stability and acceptability of natural and processed food products. For example, several researchers have shown that such products as chips and expanded corn with water activity values between 0.35 - 0.50, values that would allow a guaranteed long-term storage, actually lose in time of preservation their specific properties: crunchy effect and friability.

The bibliographic study confirmed that there is a database on water activity values for several industrialized products, namely: flours, groats, cereal mixtures with various additions of fruits, berries, seeds; biscuits, canned fruits boiled with sugar; fruits, vegetables, meat, dehydrated fish, powdered milk, powdered eggs, etc. and little data on water activity for culinary products in public catering.

The purpose of the research is to study the activity of water in various dishes and semi-culinary preparations, as well as to determine the influence of the applied heat treatment (frying, baking, boiling), the concentration of sugar and kitchen salt on the value of water activity.

Basic content

The metabolic activity of microorganisms is decisively dependent on the water available from food. A decrease in water activity has important influences on the growth of microorganisms. Different types of microorganisms exhibit different optimal growth values. Studying water activity offers the possibility of controlling microbial growth and can provide useful information on the shelf life of food and its storage without the risk of external contamination. Based on the above, culinary production depending on humidity and water activity can be classified into 4 categories of vulnerability to storage: very high (a> 0.95; W = 60-95 %), high (aw = 0.90-0.95; W=40-60%), mean (aw =0.50-0.90; W= 15-40%) and low (aw = 0.20-0.50; W=5-15%) (Table 1).

Classification of culinary production by $a_{w's}$ values

Level of water and moisture activity (%) of products	Production name	The most likely causes of spoilage of products during storage
Very tall aw>0.95 W=60…95	Vegetable semi-finished products, meat, fish Liquid preparations (soups) Funds and sauces, side dishes from boiled and fried vegetables. Meat, fish, etc.	The development of bacteria, molds, yeasts Biochemical enzymatic processes under the action of own enzymes

Tall: aw=0.90 W=40…60	French fries side dishes. Hardened vegetables	Development of molds, yeasts
Medium: aw=0,50…0,90 W=15…40	Frie fries side dishes. Articles of unleavened dough (except scalded), finishing semi-finished products, dried fruits, frozen. Dried vegetables, crechers, crisps, articles of tender dough and puff pastry	Meloidin formation reaction Development of yeasts, osmophilic molds, fermentative processes
Reduced: aw=0,20…0,50 W=5…15	Food concentrates, groats, flour. Dried products by sublimation.	Lipid oxidation reaction and non-enzymatic brownification.

Source: Tabunșcic, Olga. *Fundamentals of technological processes in public catering units*. Chisinau : AESM, 2019, p. 229

Analyzing bibliographic sources (2) it was found that different methods of heat treatment lead to obtaining finished culinary products with different values of water activity. For example, boiling vegetables in water practically does not influence the amount of water activity, but boiling in superheated steam diminishes water activity. This phenomenon is explained by higher water losses and, respectively, lower losses of mineral salts and carbohydrates during steam processing. Also, in the process of passing vegetables, a large amount of water is lost and the value of water activity decreases. In the process of frying potatoes, the value of water activity decreases in direct proportion to dehydration of the product. Experiments have shown that during heat treatment of natural meat products, regardless of the method applied, boiling or frying, the value of water activity in the finished product changes insignificantly. But for preparations made from minced meat, for example scorch, the water activity in the finished product decreases and will have different values depending on the quantity and ratio of additions (bread, potatoes, onions, etc.).

Creams and sauces prepared on the basis of different fats have different values of water activity. One of the factors influencing the value of water activity is that butter practically does not bind water.

The semi-prepared dough of bread type and scalded dough subjected to baking have quite high values of water activity, and those obtained when baking from puff pastry and tender dough have average values of water activity. The decrease in water activity in these doughs is explained by higher water losses during baking (about 13%) and structural changes in proteins and starches, plus higher sugar content.

Regarding sugars, we can mention that the value of water activity influences both the amount of carbohydrates and the molecular structure of carbohydrates. Thus, reducing larches have the property of adding more water than sucrose. Lately, more and more consumers prefer confectionery and pastries with lower sugar content. Reducing the sugar content by about 20% of the quantity prescribed in the recipe of preparations obtained from tender doughs and puff pastry, lead to an increase in aw and respectively to the reduction of the shelf life of products from 9 days to 3 days. In such cases, in order to extend the shelf life, it is recommended to use the constituents.

The research methods used were as follows:

- **Experimental methods:**

1. ***Determination of water activity.*** The preventively prepared samples are shredded, placed in special capsules and subjected to analysis by the Swiss-made LabSwift-aw apparatus having an accuracy of 0,01. Depending on the chemical composition of the products, the type of water bond, the concentration of sugar and salt, the device provides data at a different time.

2. ***Determination of humidity.*** The humidity was determined by the classical method of drying in the oven to constant mass. The results obtained are presented in Table 2.

- **Bibliographic research of scientific sources and comparison of the results obtained.**

Object of study: as object of study served following 17 dishes and semi-dishes:

1. Soft dough biscuits dusted with powdered sugar;

2. Soft dough biscuits without powdered sugar;

3. Sponge cakes with butter;

4. Classic sponge cakes;

5. Nut sponge cakes;

6. soft cookie dough;

7. Cream charlotte with walnuts;

8. Cream charlotte;

9. Syrup for syruping;

10. invert sugar syrup;

11. icing syrup;

12. French fries;

13. French fries with salt;

14. Potatoes cut salted, fried bars;

15. Cut potatoes French fries;

16. baked potatoes;

17. Mashed potatoes.

The research results are presented in Table 2.

Table 2 Values of water activity, analyzed culinary production

Name of the preparation	**Ingredients**	**a_w**	**W (%)**	**Level a_w**
Tender biscuit dough	Flour (50%), butter (26%), sugar (17%), egg (6%), baking soda(0.04%)	0,684	25	Medium
Cookies without powdered sugar	Flour (50%), butter (26%), sugar (17%), egg (6%), baking soda(0.04%)	0,330	10	Reduced
Biscuits sprinkled with powdered sugar	Flour (50%), butter (26%), sugar (17%), egg (6%), baking soda (0.04%), powdered sugar(1%)	0,284	10	Reduced
Classic sponge	(22%), starch (5%), sugar (27%), egg (45%), vanilla (0.03%)	0,624	25	Medium
Walnut sponge	flour (22%), starch (2%), sugar (27%), egg (45%), nuts (5%), vanilla (0.03%)	0,633	25	Medium
Butter sponge	flour (21%), starch (5%), sugar (26%), egg (43%), butter (4%), vanilla (0.03%)	0,623	25	Medium
Cream charlotte	butter (38%), sugar (34%), milk (22%), egg (6%), vanilla (0.03%), divine (0.14%)	0,698	25	Medium
Cream charlotte with nuts	butter (33%), sugar (34%), milk (22%), egg (6%), nuts (5%), vanilla (0.03%), divin (0.14%)	0,696	24,6	Medium
Invert syrup	(68%), water (30%), lemon salt (2%)	0,422	30	Reduced
Icing syrup	sugar (73%), water (27%), vanilla (0.03%)	0,591	25	Medium
Syrup syrup	sugar (48%), water (47%), divin (5%), vanilla (0.03%)	0,708	50	Medium
French fries	cut bars, sunflower oil	0,789	46,7	Medium
Cut potatoes, french fries with added salt	Potatoes cut bars, sunflower oil, salt	0,783	46,7	Medium
French fries	Sliced potatoes, sunflower oil	0,476	21,5	Reduced
French fries with salt	Mashed potatoes, sunflower oil, salt	0,535	21,5	Medium
Mashed potatoes with butter	Potatoes, butter	0,817	55	Medium
Baked potatoes	Sliced potatoes	0,815	30	Medium

Source: Developed by the authors

Conclusion

1. According to aw values, the analyzed culinary production falls into the following groups:

a). ***Products with low level of vulnerability to storage:*** baked biscuits from tender dough sprinkled with powdered sugar, baked biscuits from tender dough without powdered sugar, invert sugar syrup, fries fries without salt.

b). ***products with medium level of vulnerability to storage:*** fries fries with salt, sugar syrup for glazing, butter bread, classic bread, walnut bread, tender biscuit dough, charlot cream with nuts, charlot cream, sugar syrup for syruping, french fries bars with salt, french fries bars without salt, baked potatoes, mashed potatoes with butter.

2. Biscuits made from the same tender dough with powdered sugar have a lower water activity than those without sugar, therefore they will be stored without modification for a longer time.

3.The cutting form influences the activity of water. Fries that have been cut into straw have lower values than potatoes that have been cut into bars and treated by the same method.

4. The finished potato preparations obtained by baking and boiling have a higher water activity than by frying. This is explained by the addition of more water by the fat soaked by potatoes.

5. Invert sugar syrup with lower sugar concentration and higher humidity than syrup for syruping, has lower water activity, due to the fact that reducing sugar has the property of binding more water than sucrose.

6. The substitution of 5% butter according to the recipe with 5% of nuts (i.e. butterfat that practically does not attract water with another fat of vegetable origin) did not give a significant change in water activity in either creams or cakes.

References:

SANDULACHI ELISAVETA. Monograph. Water activity in food products.Chisinau: Publishing House "Tehnica-UTM", 2020. ISBN 978-9975-45-622-7.
BARANOV BORIS. Theoretical and Applied Aspects of the Indicator "Water Activity" in Food Technology: Diss. Dr. Techn. Sci. : 05.18.16 St. Petersburg, 2000 240 p. RSL OD, 71:01-5/1-9.
TABUNSHCHIK OLGA. Fundamentals of technological processes in public catering units. Chisinau : AESM, 2019. ISBN 978-9975-75-948-9.
Course support. Food chemistry. Available at : <https://irek.ase.md/xmlui/bitstream/handle/1234567890/764/Chimia%20Produselor%20alimentare.pdf?sequence=1&isAllowed=y> [Accessed 30 March 2023]
Available at : <https://www.agir.ro/buletine/20.pdf> [Accessed 30 March 2023]
Available at : <https://utm.md/meridian/2012/MI_4_2012/8_Art_Sandulachi_E_Water.pdf> [Accessed March 30, 2023