Maryam Maheri

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Section A07, Thu 9-11:50 am

Partner: Sh. G

Lab 6(methods of preserving foods by controlling their water activity)

Purpose:

The purpose of this lab is to look at the affects of food's water content and water activity on food's spoilage. Two kind of foods, dehydrated and IMF food were tested in 5 different humidity environments using 5 different saturated salt solutions.

Introduction:

There is a relationship between water content of foods and food spoilage. This is the reason we dehydrate foods to preserve them from spoilage. Water content is not same as water activity. Water content is not a good indicator for food spoilage but water activity is. Water activity means the unbounded water that is available to contact with other material and microorganism such as bacteria, yeast or molds. Water activity can also affect the non-enzymatic browning, enzymatic reaction, vitamin loss and oxidation. One thing that is important to know is that foods with higher water activity contain water that is loosely bound to the other constituents of the system not necessarily contain more water content; this is also right for foods with lower water activity, they do not necessarily contain less water, but the water that they contain is more tightly bound and thus not available to support microbial growth. There are methods that allow us to adjust water activity to be able to preserve foods longer such as adding humectant, freezing or dehydration.

Water activity (a_w) is a term describing the availability of water to microorganisms. It is only roughly related to percent moisture. Pure water has an a_w of 1.00, and the atmosphere above the water in a closed container will have an equilibrium relative humidity (ERH) of 100%. Water activity id defined as the vapor pressure of the food (system) divided by the vapor pressure of pure water under identical conditions of pressure and temperature. Water activity is in this range $0<aw<1$.

Most bacteria don't grow in a food the a_w is lower than 0.9. Bacteria require a higher a_w than yeasts (0.85), which in turn require a higher a_w than molds (0.7). Thus, any condition that lowers the a_w first inhibits bacteria, then yeasts, and finally molds. Usually there is no microbial growth when water activity is less than 0.6. At these lower limits, growths are very slow. The a_w of fully dried foods, such as crackers or sugar, is very low and such products are microbiologically stable because of this factor alone. The stability of intermediate moisture foods (aw 0.75 – 0.85), such as dried fruits, jams, and soft moist pet foods, depends on combinations of factors, such as low a_w, low pH, pasteurization, chemical additives, and impervious packaging. Foodborne microorganisms can cause food poisoning in people and this is the reason controlling water activity and adjusting it is very important in food processing and preserving.

PROCEDURE:

The procedure followed for the experiment is found in "Principles of Food Composition Laboratory Manual" (2013) Experiment 6, Food preservation by means of moisture control pages 56-69.

Data/results:

Table 1 a (raw data for dried potato flakes):

Solute	**aw**	**Dish weight (g)**	**Dish weight+sample (initial) (g)**	**Dish weight+sample (final) (g)**	**%water (initial)**
K-acetate	0.225	1.8	4.3	4.12	0.0
Mg(NO3)2	0.520	1.8	4.3	4.27	0.0
NaCl	0.755	1.8	4.45	4.55	0.0
KCl	0.845	2.0	4.5	4.81	0.0
KNO3	0.930	1.8	4.3	4.84	0.0

Table 1 b (raw data for dog food):

Solute	aw	Dish weight (g)	Dish weight+sample (initial) (g)	Dish weight+sample (final) (g)	%water (initial)
K-acetate	0.225	1.8	5.8	5.01	21.1
Mg(NO3)2	0.520	1.7	5.7	5.07	21.1
NaCl	0.755	1.8	5.8	5.43	21.1
KCl	0.845	1.9	5.8	5.88	21.1
KNO3	0.930	1.8	5.8	6.16	21.1

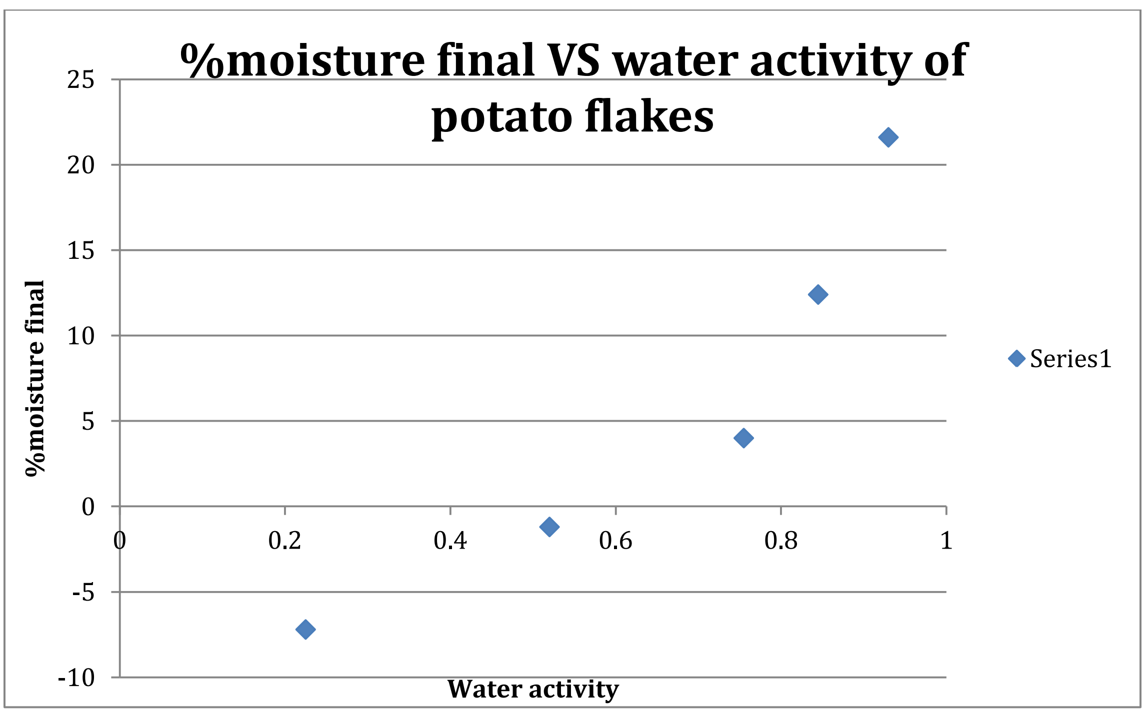
Table 2a (calculated data for dog food):

Solute	aw	WT initial (g)	WT final (g)	WT dry (g)	%moisture final	%moisture change
K-acetate	0.225	4	3.21	3.156	1.71	-25.03
Mg(NO3)2	0.520	4	3.37	3.156	6.78	-19.96
NaCl	0.755	4	3.63	3.156	15.01	-11.72
KCl	0.845	3.9	3.98	3.077	29.34	2.59
KNO3	0.930	4	4.36	3.156	43.77	11.40

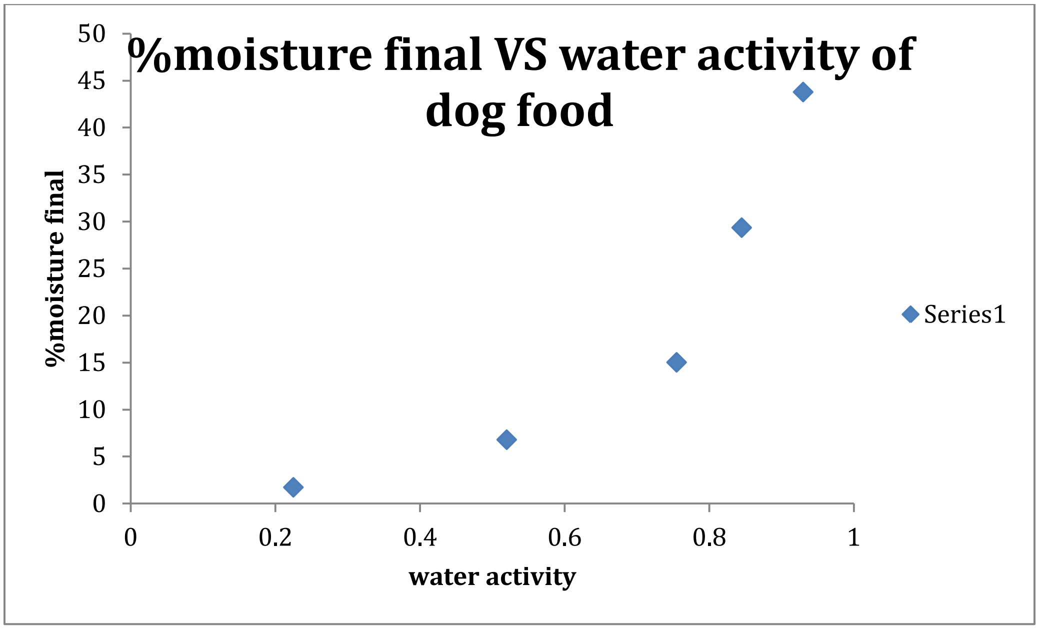
Table 2b (calculated data for dried potato flackes):

Solute	aw	WT initial (g)	WT final (g)	WT dry (g)	%moisture final	%moisture change
K-acetate	0.225	2.5	2.32	2.5	-7.2	-7.2
Mg(NO3)2	0.520	2.5	2.47	2.5	-1.2	-1.2
NaCl	0.755	2.65	2.75	2.65	4	4
KCl	0.845	2.5	2.81	2.5	12.4	12.4
KNO3	0.930	2.5	3.04	2.5	21.6	21.6

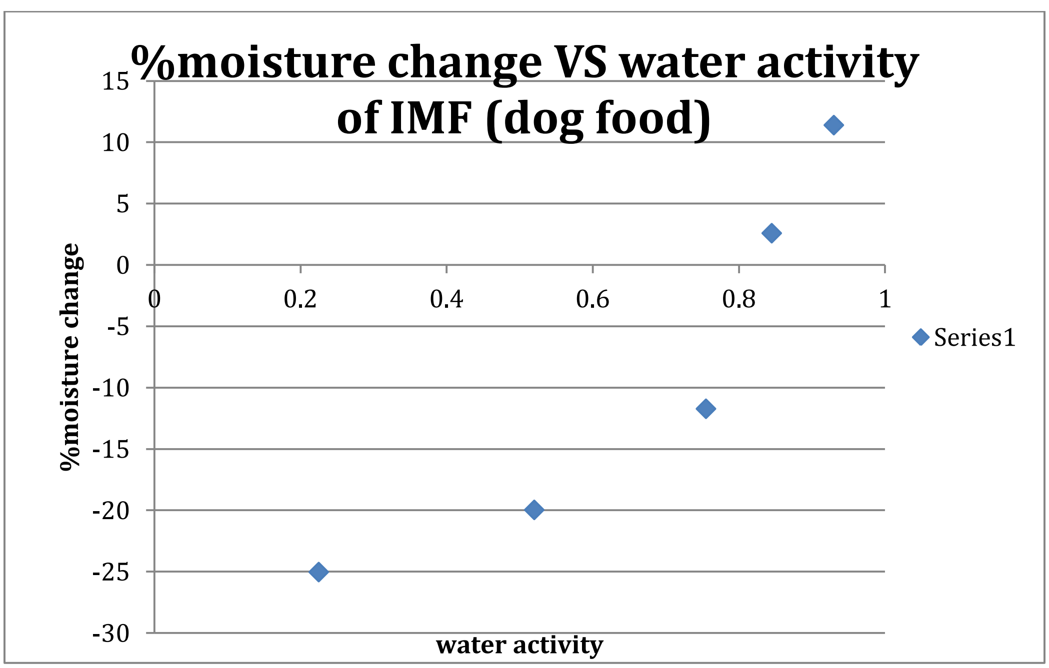
Graph 1 a (%moisture final VS water activity of potato flakes):



Graph 1 b (%moisture final VS water activity of dog food):



Graph 2 (%moisture change VS water activity of IMF (dog food):



Calculation:

WT initial= (dish +sample initial) – dish weight

K-acetate	1.8	5.8

WT initial= 5.8-1.8= 4 g

WT final= (dish +sample final) – dish weight

Mg(NO3)2	1.7	5.7	5.07

WT final= 5.07-1.7= 3.37

Wt dry= (1-X water)WT initial

Wt dry=(1-21.1)4= 3.156

% moisture final= WT final- WT dry/ Wt dry*100

%moisture final= (2.32-2.5)/2.5*100=-7.2%

%moisture change= WT final-Wt initial/Wt dry*100

%moisture change= (2.75-2.65)/2.65*100=4

Discussion:

By using different salt % RH was established. As we were using different salts we were increasing the water activity which eventually increased the %moisture final. Dog food is intermediate moisture food which is semi- moisture but potato flakes is dehydrated food. The % moisture final of both foods increased since the water activity of the salts were increased. If the potato is not dry enough it can cause some errors in our experiment. Based on our %moisture change VS water activity graph we got the water initial which was around 0.84 for dog food. for example if we look at NaCl salt at dog food we see that the water activity of this salt was 0.755 which is lower than 0.84 that we got for dog food so the dog food loses water because the ERH>%RH and this is where we see that the initial weight was 4g but then it decreased to 3.63g. In some cases the weight of the sample was increased and that is because the water activity of the salt was higher than the food sample and food gained water and the weight increased, the ERH<%RH. The water activity for dehydrated foods usually are less than 0.6 and for IMF are around 0.75- 0.85. Usually dehydrated foods are stable against microbial growth since at this water activity there is no known microbial growth but it is not stable against enzymatic reactions. IMF foods are stable against bacterial growth which grow in aw<0.9 but not stable against yeast and molds.

Conclusion:

The methods used in this lab were very easy to follow and understand. We worked on two kinds of food, dehydrated (dried potato flakes) and IMF food (dog food) in 5 different humidity environments using 5 different saturated salt solutions. Foods with two different initial water contents and water activities were placed in five different environments. We learned about the differences of water contents and water activity and how to adjust them. We learned that with the control of water activity we can preserve foods from spoilage, the non-enzymatic browning, enzymatic reaction, vitamin loss and oxidation.

Questions:

1- It is adsorption. For measuring desorption we should use a hydrated food. A hydrated food can be dehydrated to remove moisture until the desired water activity reached (desorption).
2- 0.84 is what we estimate for this part. It is not stable since yeast and molds can grow in this water activity.
3- They show both adsorption (+ sign) and desorption (- sign). Some of the moistures are increasing and some are decreasing.