WATER ACTIVITY (AW)
BY CONWAY'S MICRODIFFUSION METHOD

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INTRODUCTION

The spoilage of low moisture foods is highly influenced by their water activities. The activity of water in a mixture whether in gas phase or otherwise, is conveniently expressed as the fugacity of water in the mixture divided by the fugacity of pure water at the same temperature and its own pressure. Fugacity on the other hand is defined as the measure of the tendency of a component to escape. It has a unit and dimension of vapour pressure. Fugacity is a "corrected pressure" and water vapour pressures at ambient temperature are still low, i.e. water vapour behaves about perfectly. This justifies for normal cases to define water activity (Aw) as relative humidity shown below

$$Aw = \frac{Pws}{Pws}$$

where Pw = equilibrium water vapour pressure above the food

Pws = water vapour pressure above pure water after saturation

At water activities lower than about 0.90, most pathogenic bacteria cannot grow. For xerophilic moulds, the lowest limit is at Aw of 0.65. In between these, all types of yeasts and moulds may grow.

At very low water activities fat oxidation is promoted. If the water activity is increased, the reaction rate is slowed down at first due to stabilisation of fatty acid hydroperoxides. At higher water contents fat oxidation may be promoted again, which can be partly explained by an increase in the mobility of heavy metal ions catalysing fat oxidation.

Maillard reaction, which causes a decrease in nutritive value and undesirable sensory changes, has a maximum reaction rate in the intermediate range of water activity.

There are 2 methods of deducing water activity using Conway's unit, namely the "Sandwich" Method and the Graph Insert Method. The "Sandwich" method is used for samples whose water activity is previously known or where there is an expected water activity for the sample such as in the case of fish sausage (AW = 0.94). The Graph Insert Method is used when no previous knowledge of expected Aw is available for the sample.

APPARATUS

1. Conway's microdiffusion unit/dish and cover
2. Incubator (25°C)
3. Analytical balance (to 4 decimal places)

REAGENTS

The choice of salts used should be those with water activity in the same range as the expected water activity of the sample.

TABLE 1. Water activity (Aw) of saturated salts at 25°C.

Salts	Aw	Salts	Aw
$K_2Cr_2O_7$	0.980	$CrCl_2.H_2O$	0.708
K_2SO_4	0.968	$NaBr.2H_2O$	0.577
KNO_3	0.924	$Mg(NO_3)_2.6H_2O$	0.528
$BaCl_2.2H_2O$	0.901	$LiNO_3.3H_2O$	0.470
KCl	0.842	$K_2CO_3.2H_2O$	0.427
KBr	0.807	$MgCl_2.6H_2O$	0.330
NaCl	0.752	CH_3COOK	0.224
$NaNO_3$	0.737	$LiCl.H_2O$	0.110

PROCEDURE

Sample preparation

1. Weigh 10 - 20 g of sample and chop into 1 - 2 mm cubes.

Analytical Procedure

1. Pipette 4 ml of the standard salt solutions[*1, *2] (Aw > 0.94 and Aw < 0.94) into the outer ring of each Conway dish.
2. Weigh accurately 1 g of sample in aluminium foil dish and put into the inner ring of each Conway's dish.

3. Fix the cover with fixing reagent (white vaseline), and clip tightly.

4. Place in an incubator at a temperature of 25°± 2°C for 2 ± 0.5 hours.

5. After incubation, weigh the samples using an analytical balance.

CALCULATION

1. "Sandwich" Method

$$Aw = \frac{bx - ay}{x - y}$$

where : Aw = water activity

a = Aw of saturated A salt (Aw > 0.94)

b = Aw of saturated B salt (Aw < 0.94)

x = increase in sample weight when using saturated A salt (mg)

y = decrease in sample weight when using saturated B salt (mg)

Figures used in measurement should be in 2 decimal places e.g. 0.86.

2. Graph Insert Method

To determine the water activity of an unknown sample whose Aw is estimated to be between 0.842 and 0.968, four standards of saturated salts namely K_2SO_4, KNO_3, $BaCl_2.2H_2O$ and KCl should be used. The chopped unknown samples are weighed into different preweighed Conway units each containing one of the four salts. After incubation the percentage change in weight is recorded (Table 2). A graph of percentage weight change (vertical axis) against the water activities of standard saturated salts (horizontal axis) is plotted and the water activity of the unknown sample is the intercept of the graph against the X-axis as shown in Fig. 1 below.

TABLE 2. Graph of percentage weight change of Conway unit against water activities of saturated salts.

Saturated salt	Water activity	Weight change (%)
K_2SO_4	0.968	+4.8%
KNO_3	0.924	+2.8%
$BaCl_2.2H_2O$	0.901	+1.8%
KCl	0.842	−1.8%

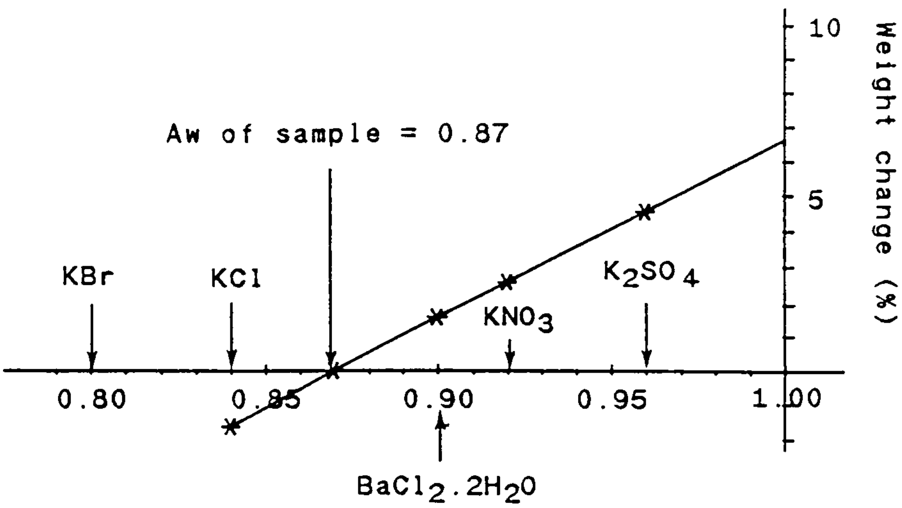

Fig. 1 Graph Insert Method

REMARKS

*1 In the case where the expected Aw is 0.94 (Japanese Agricultural Standard for Aw of fish sausage is less than 0.94), the salts used should be K_2SO_4 (Aw = 0.968) and KNO_3 (Aw = 0.924).

*2 In the case where the expected Aw is not clear, the salts used should be 4 to 5 reagents.

N.B. 1) This method is not applicable to food products containing alcohol.

2) The saturated salt solutions should be kept at 25°C.

3) Instead of using saturated salt solutions, 4 - 5 g of the reference salt (Table 1) is put into the outer ring of the Conway dish and a small amount of distilled water (0.5 - 1.0 ml) is added.

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