Measurement of Water Activity in Foods: A Review

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ABSTRACT

The large number of methods and instruments reported in the literature to measure water activity in foods are reviewed. The methods are based on the colligative properties of solutions and water activity can be determined by: (a) measurement of the freezing point depression of a liquid or (b) measurement of the equilibrium relative humidity of a solid or liquid and conversion of these measurements to water activity. The methods are divided into those requiring simple laboratory apparatus and those requiring specialized apparatus. Of the methods requiring only simple laboratory apparatus, the water sorption isotherm method is reported to have the best precision and accuracy. Disadvantages of these methods are their limited range of measurement and long equilibration times necessary before measurement. The primary advantages of methods requiring specialized apparatus are that the water activity of the sample can be more rapidly determined, fewer manipulative steps are necessary and measurements can be made over a wider range than using simple equipment. The electric hygrometer, dew point hygrometer and vapor pressure manometer are reported to give good precision and accuracy. Some methods are unsuitable to test foods containing volatiles or excessive numbers of microorganisms.

Control of water in foods is one of man's oldest means of preserving food. This method of preservation restricts the availability of water for microbial growth and biochemical reactions. Methods to control liquid water include removal of water by drying, solidifying water by freezing and addition of electrolytes such as NaCl or non-electrolytes such as sucrose. When solutes are added to water or water is removed, changes in the colligative properties occur. For example, the vapor pressure and freezing point decrease and boiling point and osmotic pressure increase. These changes result from a decrease in activity of the solvent water.

Microbial growth and biochemical reactions are determined by the degree of availability of the water in the food and this is commonly expressed as the water activity (a_w). Water activity is defined as the ratio of the equilibrium vapor pressure of the sample (P) to the equilibrium vapor pressure of pure water (P_0) at the same temperature (37). Thus water activity = P/P_0 and values range between 0 and 1. While a_w is temperature dependent, it varies only slightly over the range of temperature values that permit microbial growth (18). However, instruments used to measure a_w must often be corrected for temperature.

Since Scott (37) published his classic review on the water relations of food-spoilage microorganisms, this concept of a_w has received wide acceptance among food scientists. However, its use has been limited by a lack of reliable methods of determination (34). The purpose of this review is to compare the variety of methods available to measure a_w.

OTHER UNITS OF MEASUREMENT RELATED TO WATER ACTIVITY

Water relations are also commonly measured in terms of equilibrium relative humidity and osmotic pressure and often similar instruments are used to measure these terms and a_w. Equilibrium relative humidity (ERH) is numerically equal to a_w but is expressed as a percentage and is always 100 times larger than the a_w value. The term "a_w" is generally preferred to ERH by food scientists since a_w defines the activity of water in solids and liquids, while ERH refers to the surrounding atmosphere (37).

The term "osmotic pressure" is often used by botanists in understanding water relations of plants and is inversely related to a_w by the equation:

\[ \text{osmotic pressure} = -\frac{RT}{V \ln a_w} \]

where V is the partial molal volume of water in grams, R, the gas constant and T the absolute temperature (°C).

Osmotic pressure can be expressed in terms of atmospheres, bars or ergs cm^-3 (8). Biologists have divided osmotic pressure into solute osmotic pressure and matrix effects resulting from water-solid interactions at the surfaces of the colloids (29). Evidently food scientists have not felt this necessary in understanding water in foods.

METHODS OF MEASURING WATER ACTIVITY

The measurement of a_w is based on the colligative properties of solutions and may be measured by a number of means.

1. Measurement of the freezing point depression of a solution and conversion to a_w.
2. Measurement of the ERH of a solid or liquid. This may be determined by two means:
   (a) A quantity of the substance to be measured is enclosed with a small quantity of gas (usually air) and the relative humidity or vapor pressure of this gas is measured once equilibrium is reached.
   (b) A sample of the substance is placed in a gas at known temperature and relative humidity and the moisture absorbed or lost by the sample is determined.
In comparing these methods, the accuracy should be distinguished from the precision of a method and this has been done where possible. Often these terms have been confused in the articles under review. Precision is defined here as the reproducibility of the method when it is repeated on a homogeneous sample under controlled conditions and is represented as standard deviation (S.D.) or preferably coefficient of variation (C.V.). Accuracy refers to the degree of agreement between the \( a_w \) value measured by the test method and the true \( a_w \) value. While a method may have a high precision, there can be a significant error between the true value and the measured value. On the other hand, a method may be accurate but lack precision because of low instrument sensitivity or other factors beyond control of the analyst.

**MEASUREMENT OF THE FREEZING POINT DEPRESSION**

This method is most suitable for determination of \( a_w \) in solutions in the upper \( a_w \) range (> 0.8) and has been used under experimental conditions by some authors (14,16,25,40). The freezing point must be measured with a thermometer (either a calibrated mercury or electronic thermometer) sensitive to 0.1 C so that an \( a_w \) of three decimal places can be calculated. Usually the sample is cooled in an alcohol bath below 0 C and freezing is induced by addition of an ice crystal to the supercooled solution.

The freezing point determination of \( a_w \) is based on Raoult’s Law which states that depression of the freezing point of a solution is directly related to the lowering of the vapor pressure above the solution compared to that above pure water at the same temperature and pressure. Thus \( a_w \) is also depressed (4). The vapor pressure of the solution is determined from the freezing point depression by referring to standard tables such as in the *Handbook of Chemistry and Physics* (47) and dividing by the vapor pressure of pure water to give \( a_w \).

A second method is based on a form of Raoult’s Law which states that vapor pressure of the solvent in a solution \( (P) \) divided by the vapor pressure of the pure solvent \( (P_0) \) is equal to the mole fraction of the solvent in solution \( (N) \) (40).

\[
P \div P_0 = N = \frac{n_1}{n_1 + n_2} = a_w
\]

where \( n_1 = \) number of moles of solvent in the medium

\( n_2 = \) number of moles of solute (effective)

\( n_2 \) can be determined from the freezing point depression using the following equation:

\[
n_2 = \frac{G \Delta T_f}{1000 K_f}
\]

where \( G = \) grams of solvent used in preparation

\( \Delta T_f = \) freezing point depression in °C

\( K_f = \) molal freezing point depression constant

(1.86 for water).

The precision of the method does not appear to have been previously reported but Kang et al. (16) found the average experimental error to be ± 0.002 \( a_w \) unit.

**MEASUREMENT OF THE ERH OF A SOLID OR LIQUID**

Methods where the ERH of the sample are measured can be conveniently divided into those requiring simple laboratory apparatus and those requiring specialized instruments.

*Methods requiring simple laboratory apparatus*

Table 1 lists various methods for determination of \( a_w \) using simple laboratory apparatus. The salt-impregnated filter paper method of Kvaale and Dalhoff (19) is based on the fact that a salt will not dissolve unless the surrounding humidity level rises to a point which is equal to the saturation moisture content of the salt. Filter paper strips are dipped into various saturated salt solutions, dried and affixed inside the upper lid of a petri dish while the sample is placed in the lower dish. The petri dish is sealed and allowed to equilibrate for 20 h at 20 C. If the papers absorb moisture, the \( a_w \) of the sample is above that of the salt in the paper. Thus the \( a_w \) lies between the wet paper of the highest \( a_w \) and the dry paper of the lowest \( a_w \). Limitations are the range of \( a_w \) measurement and an accuracy dependent upon the choice of salts for preparing the filter papers. The authors reported an accuracy of 0.005 \( a_w \). The \( a_w \) of bacon has been determined by this method (19).

Solomon (39) developed a simple method for

<table>
<thead>
<tr>
<th>Method</th>
<th>Range of ( a_w ) measurement</th>
<th>Precision</th>
<th>Accuracy ( a_w ) unit</th>
<th>Equilibration time (h)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt impregnated filter paper</td>
<td>0.9 -1.0</td>
<td>N.S.³</td>
<td>0.005</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Humidity-induced color changes</td>
<td>0.3 -1.0</td>
<td>0.05-0.15b</td>
<td>N.S.</td>
<td>2</td>
<td>39</td>
</tr>
<tr>
<td>Water sorption isotherm (protein)</td>
<td>0.79-0.99</td>
<td>0.003-0.012b</td>
<td>N.S.</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>Water sorption isotherm (micro-crystalline cellulose)</td>
<td>0.85-0.98</td>
<td>1.1%±2.5%</td>
<td>N.S. 0.002-0.02</td>
<td>24</td>
<td>21,22,44</td>
</tr>
<tr>
<td>Graphical interpolation</td>
<td>0.989</td>
<td>8.6%³±0.2%±2.5%</td>
<td>N.S.</td>
<td>1-24</td>
<td>23,24,31,33</td>
</tr>
</tbody>
</table>

³Not stated in publication.

⁴Confidence limits in \( a_w \) unit.

⁵Coefficient of variation.
measurement of the a_w of grain based on color changes of cobalt thiocyanate with ERH. Paper is impregnated with the salt and equilibrated in the atmosphere of the sample. The paper is immediately mounted on white opal glass in oil and matched with standards of known a_w. The method was used over a wide a_w range (Table 1) and only 2 h of equilibration is necessary. Between 0.7 and 1.0 a_w, the 95% confidence limits of the method were ± 0.05 a_w unit. However, the confidence limits dropped to ± 0.15 a_w unit for measurements between 0.3 and 0.7 a_w.

A method was recently developed for measurement of a_w using a water sorption isotherm standard (Table 1) (10, 44). The particular sample is placed in a desiccator containing a known weight of dried protein (10) or microcrystalline cellulose (44), evacuated and allowed to equilibrate. The amount of water taken up by the protein or cellulose is dependent upon the original a_w of the sample and the a_w is read off a standard water sorption isotherm. Labuza et al. (21) reported that microcrystalline cellulose was more stable as absorbant than the protein. The method has successfully been used to measure a wide range of meat, dairy, dessert, bakery and microcrystalline cellulose (10, 44). Water sorption isotherms have a number of disadvantages: (a) variations in the composition of the food sample from that used to construct the original isotherm can result in an incorrect a_w value (4) and (b) many hygroscopic solid foods exhibit hysteresis in their water sorption isotherms (20). Further details are provided by Gál (11) and Loncin et al. (26).

Methods requiring specialized apparatus

The dew point method. The sample is placed in a chamber containing a mirror, sample holder and a means of detecting condensate on the mirror and allowed to equilibrate with the surrounding air space. The a_w is determined by cooling the mirror until droplets of water vapor form on the mirror at which point the temperature is measured. This is the dew point temperature and is directly related to the a_w of the sample (2). The a_w can also be obtained from the vapor pressure in the chamber at dew point (7), but Anagnostopoulos (2) reported that temperature measurement is usually easier. The mirror can be cooled by Peltier cooling (2, 24) and by using coolants such as petroleum (3) or acetone (7). The dew formed may be observed visually or with a photo-electric cell (4).

A_w values between 0 (7) and 1 (3, 24) have been measured with the dew point apparatus (Table 2). The precision (S.D.) of the method is reported by Northolt (31) to be 0.003 a_w unit while the accuracy varies between 0.003 and 0.005 a_w unit (Table 2). An equilibration time between 2 and 3 h is recommended before the a_w of solid food can be measured (24). However, the equilibration time before the a_w of liquid is measured can be as short as 10 min (7). An additional advantage is that determinations can be made over a wide range of temperatures of equilibration. Most authors (2, 7, 31) have constructed their own apparatus for dew point measurement. However, Rödel and Leistner (35) adapted a commercial dew point hygrometer (EG and G, Waltham, MA; Model 880) to measure a_w.

The a_w of foods such as syrups (7), solid bakery products (7), wheat, sorghums, kernels, groundnut meal, coffee beans, blackseed pepper (3) and meats (24) have been measured using this technique. Electronic hygrometers. These instruments are widely used to measure the a_w of foods in spite of their expense. Their popularity is based mainly on precision, accuracy and convenience and there are a number of different types of instruments available commercially. The instrument consists of a sensor containing a hygroscopic
material, usually LiCl, a sample chamber and a potentiometer. The conductivity of the hygroscopic material in the sensor changes according to the relative humidity in the chamber above the sample (24, 27, 42). The Sina-equihygroscope (Nova Sina, Zürich, Switzerland; marketed in U.S.A. by Beckman Instruments, Inc., Cedar Grove, N.J.) is based on this principle. The instrument is able to measure \( a_w \) between 0.02 and 0.99 by changing the sensor (Table 2). A precision (C.V.) of 0.27% (15) to 0.53% (42) has been reported while the accuracy varies between 0.002 (43) and 0.02 \( a_w \) unit (21). The accuracy of the instrument is dependent on calibration against saturated salt solutions and use of standard calibration curves (24). Equilibration times of 30 min (21) to 24 h (15) have been recommended for measurement of the \( a_w \) of food. Long equilibration times pose the danger that the \( a_w \) of the sample may change as a result of microbial growth.

The Hygrodynamics hygrometer (American Instrument Co., Silver Spring, MD) is similar to the Sina instrument and measures \( a_w \) values between 0.05 and 0.99 using various sensors. Precision (C.V.) between 3.6 and 4.8% (21) and accuracies between 0.005 (6) and 0.11 (21) have been reported.

An electric hygrometer (Phys-Chemical Research Corp., New York) used by Hagerdal and Lofqvist (13) to measure the \( a_w \) of food proteins is based on the change of resistance of sulfonated polystyrene in the sensor with change in relative humidity. \( a_w \) values between 0.11 and 0.92 can be measured. The maximum error of the instrument was 0.016 \( a_w \) unit while 1 h was required for equilibration. An advantage of the instrument is the samplsize (0.3 - 0.8 g) necessary for a measurement.

Some workers have reported that hygrometers are inaccurate at \( a_w \) values above 0.90 (10, 44) and the sensors lose accuracy with age (11, 13, 44). They are also subject to errors due to absorption of volatiles such as glycerol (42, 44). Troller (42), on the other hand, found the precision of the Sina-equihygroscope to improve with greater \( a_w \) values. He found contamination to be transitory depending on the degree and duration of exposure. Sensor accuracy recovered within 1 or 2 wk at ambient relative humidity and temperature. Labuza et al. (21) removed contaminants such as water, propylene glycol and glycerol by keeping the sensor in an evacuated desiccator. The manufacturers of the Sina-equihygroscope also supply filters that will screen the sensor from volatile compounds.

Electric hygrometers have been used to measure the \( a_w \) of a wide range of foods including meats, fermented sausage (24), cheese, bread, intermediate moisture foods, dry soup mix (21), fruit jelly and chocolate syrup (42).

**Hair hygrometers.** These instruments are extensively used for routine measurement of the \( a_w \) of meat products in food inspection laboratories in Germany (24, 36). The measurement of \( a_w \) is based on the change of the length of a hair with change of relative humidity in an enclosed chamber (31). The instrument manufactured by Luft Metallbarometerfabriek (Stuttgart, Germany; marketed in U.S.A. by Abbeon Cal Inc., Santa Barbara, CA) has been used by Leistner’s group to measure the \( a_w \) of meats in the range of 0.85 to 1.00, although the manufacturers suggest that \( a_w \) values down to 0.4 can be measured. The instrument should be calibrated at least weekly (36) and preferably just before use at the same temperature as for the sample. About 3 h of equilibration at constant temperature is necessary before reading (24), although Labuza et al. (22) suggested that a longer period is necessary at high \( a_w \) values. The manufacturer recommends equilibration at 20 °C. If this temperature is not convenient, the \( a_w \) may be corrected for temperature, although they are most accurate when kept at constant temperature in an incubator. Rödel et al. (36) reported a precision (C.V.) between 0.26 and 0.36% for two sets of nine determinations of sausage, although Labuza et al. (22) found the instrument to be less precise (C.V. = 2.18%) when measuring the \( a_w \) of Parmesan cheese of 0.73 \( a_w \). Measurements in most instances are within 2%

<table>
<thead>
<tr>
<th>Method or instrument</th>
<th>Range of ( a_w ) measurement</th>
<th>Precision</th>
<th>Accuracy (( a_w ) unit)</th>
<th>Equilibration time</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG and G dew point hygrometer</td>
<td>0.72 - 1.00</td>
<td>N.S.(^a)</td>
<td>0.003</td>
<td>2-3 h</td>
<td>23,35</td>
</tr>
<tr>
<td>Laboratory made dew point hygrometer</td>
<td>0.75 - 0.99</td>
<td>N.S.</td>
<td>0.003</td>
<td>15 min</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0.3 - 1.00</td>
<td>N.S.</td>
<td>0.003 - 0.005</td>
<td>N.S.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.003b</td>
<td></td>
<td>0.005</td>
<td>N.S.</td>
<td>31</td>
</tr>
<tr>
<td>Hygrodynamics hygrometer</td>
<td>0.05 - 0.99</td>
<td>3.6% - 4.8%(^d)</td>
<td>0.005 - 0.11</td>
<td>1-24 h</td>
<td>6,9,21,32,41,44</td>
</tr>
<tr>
<td>Sina equihygroscope</td>
<td>0.02 - 0.99</td>
<td>0.27% - 0.53%(^d)</td>
<td>0.002 - 0.02</td>
<td>0.5 - 24 h</td>
<td>15,21,31,42,43,45</td>
</tr>
<tr>
<td>Phys-chemical hygrometer</td>
<td>0.11 - 0.92</td>
<td>N.S.</td>
<td>0.016</td>
<td>1 h</td>
<td>13</td>
</tr>
<tr>
<td>Lufti hair hygrometer</td>
<td>0.4 - 1.00</td>
<td>0.26% - 2.18%(^d)</td>
<td>0.02</td>
<td>3 h</td>
<td>22,36</td>
</tr>
<tr>
<td>Wescor psychrometer</td>
<td>0.935 - 1.00</td>
<td>0.18% - 0.35%(^d)</td>
<td>N.S.</td>
<td>1 h</td>
<td>33</td>
</tr>
<tr>
<td>Vapor pressure manometer</td>
<td>0.0 - 0.9</td>
<td>0.62% - 1.20%(^d)</td>
<td>0.005(^e)</td>
<td>1 h</td>
<td>17,20,21,22,44</td>
</tr>
</tbody>
</table>

\(^a\)Not stated.
\(^b\)Standard deviation in \( a_w \) unit.
\(^c\)At 0.85 \( a_w \).
\(^d\)Coefficient of variation.
of the value of the Sina-equlhygrooscope when meat samples are tested (36). Labuza (20) reported that hair hygrometers are most accurate between 0.3 and 0.8 \( a_w \). Presence of volatile glycols during long equilibration periods may damage the sensitivity of the instrument (22).

**Psychrometers.** The water relations of plant material are often measured using psychrometers (8,46). Prior et al. (33) have used a psychrometer (Wescor Inc., Logan, Utah) to measure the \( a_w \) of solutions and foods such as bread, cheese and meat. The instrument consists of a chamber containing a thermocouple. The sample is placed in the chamber and allowed to equilibrate for at least 10 min (for liquids) or 1 h (for foods). The water vapor is cooled by Peltier cooling and water vapor condenses on the thermocouple. The rate of evaporation from the thermocouple into the vapor state is proportional to the psychrometer reading and the \( a_w \) is determined from a standard curve prepared against standards of known \( a_w \). While the thermocouple of the psychrometer may become contaminated with repeated use, it is easily cleaned.

While the range of the Wescor psychrometer is limited to \( a_w \) values between 0.935 and 1.0 (33), other instruments such as the electric hygrometer are reported to be inaccurate in this range (10,44) and thus the psychrometer can complement other instruments for measurement of moist foods. The Wescor psychrometer has a precision (C.V.) between 0.18 and 0.35% \( a_w \) unit when used to test foods (33).

**Vapor pressure manometers.** Manometers are used to determine \( a_w \) by measuring the vapor pressure directly above foods (1,17,44). The sample is placed in a flask connected to a manometer and evacuated so that minimum moisture is lost from the sample. The system is kept at constant temperature and the sample is allowed to equilibrate for approximately 1 h (20). The vapor pressure is measured. The evaporated water is then removed and the vapor pressure of the remaining gases and volatiles is measured. The \( a_w \) of the food is obtained from the difference between the two readings divided by the vapor pressure of pure water at the same temperature (21).

The method is effective over an \( a_w \) range between 0 and 0.9 (17,44). At \( a_w \) values above 0.9, the method is inaccurate because of temperature control problems (44). At an \( a_w \) value of 0.85, the accuracy is \( \pm 0.005 \) (1) but above 0.85, the accuracy falls to \( \pm 0.02 \) (44). At \( a_w \) values below 0.9, short equilibration time and poor temperature control can also lead to inaccurate results (22). A precision of 1.20% (C.V.) has been reported for measurement of saturated LiClSO\(_4\) solutions (21), 0.62% for Parmesan cheese and 1.02% for dog food (22).

Labuza's group has used the method to measure the \( a_w \) of foods such as pet foods, bread, pancake batter, cheese, soup mix and egg products (21,38). The method cannot be used for fermented foods or samples supporting microbial growth because of gas evolution. The presence of volatiles in the food may contribute to the vapor pressure and give erroneous results. However, foods containing glycerol and propylene glycol have been measured successfully (21).

**Other instruments.** While the osmometer is commonly used to determine osmotic pressure, Mozumder et al. (28) used a vapor pressure osmometer (Wescor Instruments Inc., Santa Clara, CA, Model 232) to measure the \( a_w \) of experimental solutions with \( a_w \) values greater than 0.9674. These instruments are generally limited to determining \( a_w \) in the upper range and their expense detracts from their wide use as \( a_w \) meters.

Norrish (30) constructed an instrument to determine the \( a_w \) of confectionery syrups based on the change of resistance of a ceramic pellet (doped and fired titanium dioxide) with a change in relative humidity. The pellet was placed in a measuring cell containing the sample and equilibrated at 25°C for 1 h. The instrument was used between 0.5 and 1.0 \( a_w \). At \( a_w \) values between 0.9 and 0.95, an accuracy of \( \pm 0.001 \) \( a_w \) was observed but fell to \( \pm 0.02 \) \( a_w \) between 0.5 and 0.55 \( a_w \).

A pressure cell was developed by Gur-Arieh et al. (12) to measure the \( a_w \) of flour with a high moisture content. The flour sample was allowed to equilibrate for 36 h or longer with water under pressure separated from the sample by a porous membrane. After equilibration at constant temperature the water content of the sample was analyzed. The thermodynamic relationship

\[
\Delta P = \frac{RT}{V(a_w - a_w^*)}
\]

\( V \) in \( a_w \), enabled calculation of the \( a_w \) from the pressure applied (\( \Delta P \)) and the moisture content of sample after equilibration. The authors reported a range of 0.67 to 0.96 \( a_w \) for the apparatus.

**CONCLUSIONS**

This paper has attempted to review the available information on the measurement of \( a_w \) in foods. Comparison of the methods is complicated by research workers often failing to distinguish between the precision and accuracy of a method and also using different statistical methods for determination of these parameters. Use of saturated salt solutions to check accuracy is often unreliable as different \( a_w \) values have sometimes been reported for the same salt in the literature (21,31).

The freezing point method and methods summarized in Table 1 have the advantage that simple laboratory equipment may be used and the cost of the determination is kept to a minimum. Most of these methods are used to measure \( a_w \) of a wide range of foods in the upper range (> 0.7 \( a_w \)). The best precision and accuracy has been reported for the water-sorption isotherm methods (10,44). With exception of the humidity-induced color change method (39), all the methods require a long equilibration time before measurement and this can sometimes result in interference by microbial growth during equilibration. Labuza et al. (21) prevented microbial growth during equilibration by addition of potassium sorbate to the
food being tested, but whether the salt significantly reduced the $a_w$ of the food, was not mentioned. The filter paper method is that the $a_w$ of the foods over the full range. In a controlled comparative study of various instruments, Labuza et al. (21) recommended the vapor pressure manometer as it gave better precision and accuracy than the Hygrodynamics and Sina hygrometers when used to measure a wide range of foods and saturated salt solutions.

In a subsequent comparative study, Labuza et al. (22) found that the water sorption isotherm procedure and the Lufft hair hygrometer gave similar $a_w$ readings when used to test foods and standards and were reasonably accurate. The vapor pressure manometer, on the other hand, gave a significantly lower $a_w$ but was more precise than the other two methods.

Other factors which affect the accuracy and precision of these methods are control of equilibration temperature, frequent calibration of instruments and training of technicians to carry out determinations (22). While a number of instruments have temperature-compensating devices so that measurements may be made at room temperature, better results are generally obtained by equilibrium at constant temperature.

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REFERENCES

Mycoplasma Mastitis Alert

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Mycoplasma are small microbes intermediate in character between viruses and bacteria and several species cause mastitis.

Mastitis due to mycoplasma should be suspected if the following occurs:

1. An increase in severe mastitis cases that resist treatment but cows are not sick.
2. Mastitis cases which typically involve more than one quarter (often all four quarters) in the same cow.
3. Marked loss of production in affected cows. Some may simply just dry up.

Any of the above can occur occasionally with mastitis due to other causes but a pattern of cases like these suggests that mycoplasma may be the cause. Some infected cows do not show many signs of mastitis and may be a source of spread in the herd. Such carrier cows may also be purchased unknowingly and spread infection in a previously clean herd.

Diagnosis

Whenever mycoplasma mastitis is suspected, milk samples should be collected and submitted through a veterinarian for laboratory culture with a special request for a mycoplasma culture.

Prevention

Since some herds have become infected through purchase in infected carrier cows, it is a good practice to check all purchased cows for all mastitis bacteria, including mycoplasma, before putting the cows in the regular herd. A culture of bulk tank milk from the herd of origin may reveal the mycoplasmas are present in that herd. Never milk fresh cows in a hospital barn or string where cows with mastitis are milked. Always use very careful hygiene practices when treating cows for any kind of mastitis since careless treatment can spread mycoplasma and other serious forms of mastitis.

Control

Treatment is not usually effective. Control must therefore be accomplished by segregation and/or culling of infected cows since the major means of spread appears to be from infected cows to clean cows during milking.

Selection of specific procedures for a given herd should be made in consultation with the herd veterinarian who is familiar with circumstances at the dairy.

Current Guidelines for Elimination of Mycoplasma Mastitis from Dairy Herds

1. Culture all cows, or all cows in infected strings, using composite samples (one sample includes milk from all four quarters). Appropriate samples of bulk tank milk may help to classify strings as infected or not infected.

2. Remove all cows with positive mycoplasma milk cultures from the main milking strings of the herd.

The following alternatives may be considered:

A. Market infected cows for slaughter. This is the recommendation of choice for most severe clinical infections or for herds with only a few infected cows.

B. Segregate infected cows. Those that recover can be milked but should not be returned to herd strings until two or more negative tests have been obtained.

C. Dry infected cows and resample at least two times after freshening. Remove cows positive at that time.

D. Cows without obvious mastitis and yielding only small numbers of organisms should be removed from the main milking strings until two consecutive re-examinations show them to be negative strings. Do not mingle these with clinical cows or with negative strings.

3. Monitor the herd weekly by sampling the tank milk after each string is milked once each week until four negative tests have been ob-