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Arbor Acres update

Water Quality

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This Arbor Acres Update has been written specifically for producers in Asia and the Middle East where typical ambient temperatures can range from below freezing to above 50°C. This advice may be useful in other regions, but please discuss with your local Technical Service Manager.

Executive Summary

Water is an essential ingredient for life. Any reductions in water intake or increases in water loss can have a significant effect on the lifetime performance of the chick.

Water intake increases with age and is higher in males than females. These effects should be taken into account when considering the supply of water to the poultry house.

Environmental temperature can impact heavily on water intake; intake will increase by 6-7% for each degree above 21°C. It is therefore essential that water availability reflects changes in environmental temperature. Water temperature can also influence water consumption. Stored water will be at a temperature similar to that of its environment. In cold climates this is not significant, but in hot climates water intake may be reduced due to an increase in water temperature. Where water temperature regularly exceeds 24°C, methods to control water temperature should be developed (e.g flushing of drinker lines, using a cool pad, insulating water pipes and tanks).

The supply of water reaching the birds should be clean, uncontaminated and freely available throughout the whole production period. Regular assessments of water quality are necessary to ensure that microbial load and mineral content are within acceptable levels so that bird performance is not compromised.

In conclusion, it is vital to ensure that an adequate, clean supply of water is provided if optimal bird performance is to be achieved.

Introduction

Water is an essential biological ingredient of life. Not only is it a vital nutrient, but it is also involved in many essential physiological functions such as:

- Digestion and absorption, where it supports enzymatic function and nutrient transportation.
- Thermoregulation.
- Lubrication of joints and organs and the passage of food through the gastrointestinal tract.
- Elimination of waste.
- It is also an essential component of blood and body tissues.

Chickens consume about twice as much water as food, although this ratio can be much higher during hot conditions. About 70% of a chick's weight is water (this can be as high as 85% at hatch), therefore any reduction in water intake or increase in water loss will have a significant effect on the lifetime performance of the chick.

Due to the essential role that water plays in the health and performance of biological systems, it is vital to ensure that an adequate clean supply of water is provided if optimal bird performance is to be achieved.

This Arbor Acres Update provides information on the factors that influence water consumption and water quality, highlighting methods to maintain and/or increase water intake and discussing what constitutes good water quality and how to maintain it.

Water Losses

The water intake of the body should remain in balance with the water loss if dehydration is to be avoided. The main sources of water loss are respiration, transpiration and excretion of feces and urine. Fecal water loss is about 20-30% of the total water consumed, but the most important loss of water is via the urine. The characteristics of water loss will change, depending on the environment and the humidity, for example, while evaporative heat loss may represent only 12% of the water loss in birds at 10°C, it can increase to 50% when the environmental temperature reaches 30°C. This is a critical factor with regard to the chick where water represents a larger proportion of its weight.

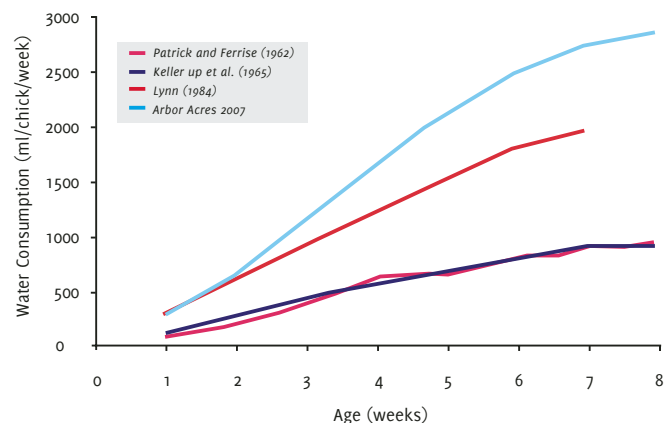
Key Point

- Immediate water availability when chicks are placed in the house is important if permanent damage to the biological performance of the flock is to be avoided.

What Influences Water Consumption in Chicks?

Age: Water intake is closely linked to feed intake and bird age (growth response). As the bird gets older, the demand for water will increase (Figure 1). Water quality and availability therefore have the potential to impact heavily on the growth performance of the modern broiler and any husbandry technique that limits water (such as part house brooding or failing to increase drinker space in the first 10 days) will have a parallel negative effect on growth.

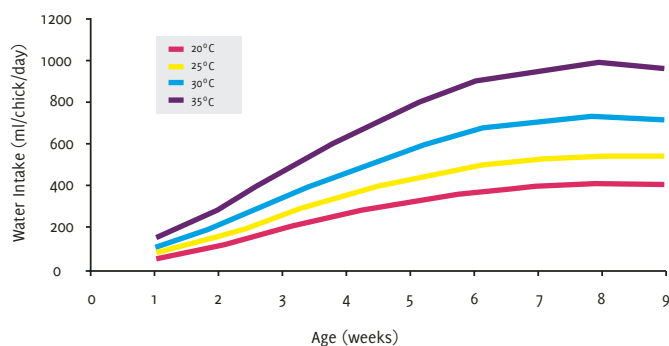
Figure 1: Water Consumption (ml/chick/week). Adapted from Bailey, 1999 and the Arbor Acres Broiler Performance Objectives, June 2007 (based on the assumption that water intake is 1.8 times that of feed intake).



Sex: The sex of the bird will also affect water intake. The water intake of males will be greater than that of females from the first week of life. Water:feed ratio is also higher in males than in females. Adipose tissue differences between the sexes explain these differences in water intake (females being fatter than males; fat has a lower water content than protein).

Environmental Temperature: Environmental temperature can impact heavily on water intake (Figure 2). The water intake of chickens is approximately double that of feed intake (1.8:1, at a temperature of 21°C in bell drinkers). However, in heat-stressed birds this level will be increased. A chicken's water intake will increase by 6-7% for each degree above 21°C (NRC, 1994).

Figure 2: Effect of Environmental Temperature on Water Intake (based on daily feed consumption defined in the Arbor Acres Broiler Performance Objectives, June 2007 and the assumption that water intake increases by 6% per °C increase in temperature, Singleton, 2004).



It is strongly recommended that each house has a water meter installed and that accurate daily records of water intake are maintained.

Key Points

- Increases in water intake will occur with age and environmental temperature.
- Water availability must reflect these changes if performance is not to be restricted.
- Each house should be fitted with a water meter.

Water Temperature: With the exception of water used for vaccination, little thought is given to the temperature of the water presented routinely to birds. Stored water tends to be at a similar temperature to that of its environment. This is not significant in cold climates, but in hot climates water consumption will be reduced as the water temperature increases. Work by Beker and Teeter (1994) found the preferred water temperature of birds to be around 10°C, with water temperatures of 26.7°C and above leading to significant reductions in water consumption and daily weight gain. It is therefore important to regularly monitor water temperature. If it regularly exceeds 24°C, then thought should be given to developing methods of cooling water temperature in hot weather. This may involve run-

ning the drinker supply pipes through a cool pad reservoir or even across the face of the cool pad airflow. Positioning the water tank and supply pipes underground will also help to protect the water from the ambient air temperature, keeping it cool. Pipes and tanks that are exposed to the sun should be insulated and shaded to prevent heat gain. It is also good practice to flush the drinker lines at regular intervals in hot weather to keep the water as cool as possible.

For vaccination the target water temperature should be <20°C. In hot weather this can be achieved through the addition of ice to the storage tank before vaccination commences. It is important to ensure that all the ice is melted before addition of the vaccine to prevent non-uniform mixing.

Key Points

- Regularly monitor water temperature.
- If it regularly exceeds 24°C, methods to control water temperature in hot weather should be developed.
- The target temperature for vaccination is <20°C, if necessary this can be achieved through the addition of ice to the storage tank.

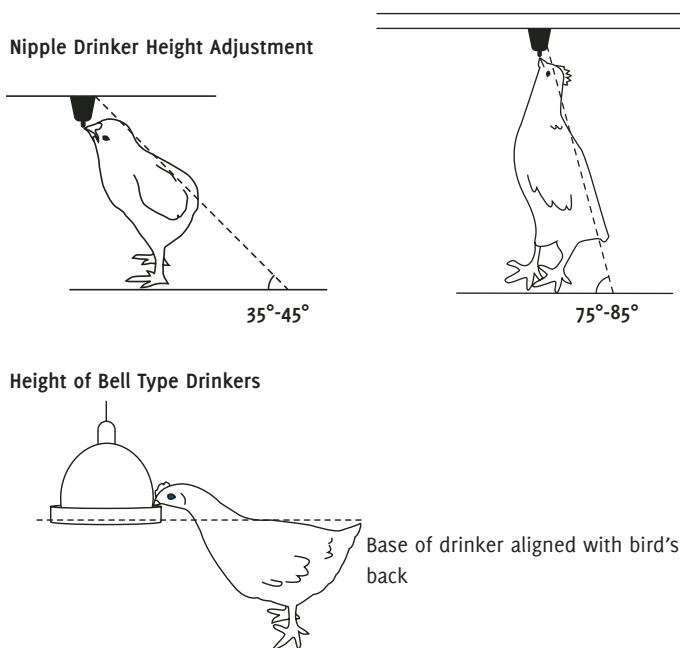
Drinking Systems: In most modern broiler units nipple drinkers are the system of choice, these have the advantage of reducing disease spread, providing cleaner water and reducing the labor requirements for clean out. However, good management is necessary for the proper operation of nipple drinker systems. Management factors that influence water intake in such systems are water line height (birds should lift their heads to reach the nipple drinker which should be higher than the birds' back to prevent bumping and leakage, see Figure 3), water line maintenance (regular flushing and cleaning), drinker line location and water pressure.

Nipple flow rate will also influence water consumption and should be checked regularly against the manufacturer's recommendation. The flow rate should be correct in all drinker lines throughout their entire length. For young chicks water pressure (and hence flow rate) should be low. Pressure should be gradually increased with age and weight so that water flow is increased as birds get older in accordance with demand. As a general rule, water pressure should be adjusted so that there is a flow rate of at least 60ml/min available from each nipple. To achieve good performance the nipple lines should be controlled to meet the birds' requirement rather than to simply protect the litter. In general, the systems with higher flow rates produce better growth rates by increasing both feed and water consumption, but water leakage and litter deterioration is more likely.

The negative growth impact of low nipple flow rates is most commonly seen in birds growing to higher weights (>2kg), where the increased water demand cannot be met and feed intake is reduced. The effect of low nipple flow rates is even clearer if the stocking density is increased and the bird:nipple or bird:drinker ratio is high. As a useful guide, the Lott equation to calculate static weekly flow: $(\text{weeks of age}) * 7 + 20\text{ml/min}$ may be a helpful reference.

Where bell drinkers are the system of choice, drinkers should be cleaned daily to prevent the build up of organic matter. Height should be adjusted so that the base of the drinker is level with the broiler's back from 18 days onwards (Figure 3).

Figure 3: Drinker Height of Bell and Nipple Type Drinkers



No matter what drinker system is installed, the provision of adequate drinker space is essential if water intake is not to be reduced. As a guide, 83 nipples or 8 bell drinkers per 1000 birds should be provided post-brooding. Where ambient temperatures and/or heavier liveweights (>2kg) are used, drinker space should be increased by up to 50% of these guidelines.

Key Points

- In most broiler units nipple drinkers are the system of choice. Good management of these systems is critical with water line maintenance, drinker line location, water pressure and nipple flow rate all affecting water intake.
- Regardless of the water system in place, drinker height and provision of adequate drinking space is critical.

Feed Effect on Water Intake: Any nutrient that promotes mineral excretion through the kidneys also promotes increased water consumption. Therefore, excess minerals in feed or water above nutritional requirements will lead to an increase in water intake. This is also true for high protein diets where any protein not used for protein synthesis is deaminated and excreted in the urine. This energy-demanding process is associated with an increase in water loss.

In particular, the presence of inorganic elements such as sodium (Na), potassium (K), and chloride (Cl) will be associated with increased water

consumption and wetter droppings. A moderate increase in dietary sodium is not normally a problem where birds have access to low sodium drinking water; they will increase the water intake if the diet is high in salt and excrete the excess. However, in areas where water sodium levels are elevated, it is important to factor this added supply into practical diet formulation, otherwise unevenness and poor growth rate will occur. Arbor Acres recommends 0.16–0.23% sodium in broiler diets. These reflect total sodium intake and therefore any contribution from the water should be included.

The dietary requirement for potassium is low, 0.4–0.9% being adequate, levels of intake above this may, however, have a thirst-inducing effect, increasing fecal moisture. This is normally seen where soya is used as the single protein source to provide high protein starter diets. However, in the past, in Northern Europe, molasses feed additives contributed to this effect. The general standard should be to control dietary potassium to a total intake of <0.9%, however, under conditions of heat stress dietary levels of potassium may need to be increased to 1.5–2.0% due to increased renal excretion.

Chloride levels should equal sodium levels (0.16–0.23%). The total chloride level is generally constrained by delivering a proportion of the sodium requirement as sodium bicarbonate rather than as salt (sodium chloride). Deficiency states are uncommon.

Key Points

- Excess levels of some inorganic elements such as Na, K and Cl will increase water intake and occurrence of wetter droppings.
- Dietary levels of these elements should be in line with Arbor Acres Broiler Nutritional Recommendations.

Water Quality

A supply of clean, uncontaminated water should be freely available to the birds at all times. However, depending on the source, the water supplied to the birds may contain excessive amounts of various minerals or be contaminated with bacteria. Acceptable levels of minerals and organic matter in the water supply are given in Table 1 (page 4).

Regular assessments of water quality are necessary for monitoring microbial load and mineral content. The water supply should be checked for the level of calcium salts (hardness), salinity and nitrates. After cleaning out and prior to chick delivery, water should be sampled for bacterial contamination at source, from storage tanks and from drinkers. Regular assessments of water quality throughout the production period itself should also be made. Ideally, these should be taken from a tap between the tank and the first drinker. Where the facility of a tap does not exist, the water sample should be taken from the first drinker. The main water connection at the top of the drinker should be removed and drained so that any build up of bacteria and debris can be flushed through allowing an accurate water sample to be taken. Water should be left running for at least 2 to 3 minutes before the sample is taken. As with all testing, the results should properly reflect the water status and therefore care to avoid contamination either during sampling or during transport to the laboratory is necessary.

Table 1: Water Quality Criteria for Poultry

Criteria	Concentration (ppm)	Comments
Total Dissolved	0-1000	Good
Solids (TDS)	1000-3000	Satisfactory: Wet droppings may result at the upper limit
	3000-5000	Poor: Wet droppings, reduced water intake, poor growth and increased mortality
	>5000	Unsatisfactory
Hardness	<100 Soft	Good: No problems
	>100 Hard	Satisfactory: No problem for poultry but can interfere with effectiveness of soap and many disinfectants and medications administered via water
pH	<6	Poor: Performance problem, corrosion of water system
	6.0-6.4	Poor: Potential problems
	6.5-8.5	Satisfactory: Recommended for poultry
	>8.6	Unsatisfactory
Sulphates	50-200	Satisfactory: May have a laxative effect if Na or Mg >50ppm
	200-250	Maximum desirable level
	250-500	May have a laxative effect
	500-1000	Poor: Laxative effect but birds may adjust, may interfere with copper absorption, additive laxative effect with chlorides
	>1000	Unsatisfactory: Increases water intake and wet droppings, health hazard for the young birds
Chloride	250	Satisfactory: Highest desirable level, levels as low as 14ppm may cause problems if sodium is higher than 50ppm
	500	Maximum desirable level
	>500	Unsatisfactory: Laxative effect, wet droppings, reduces feed intake, increases water intake
Potassium	<300	Good: No problems
	>300	Satisfactory: Depends upon the alkalinity and pH
Magnesium	50-125	Satisfactory: If sulphate level >50ppm magnesium sulphate (laxative) will form
	>125	Laxative effect with intestinal irritation
	350	Maximum
Nitrate Nitrogen	10	Maximum (sometimes levels of 3mg/l will affect performance)
Nitrates	trace	Satisfactory
	>trace	Unsatisfactory: Health hazard (indicates organic material fecal contamination)
Iron	<0.3	Satisfactory
	>0.3	Unsatisfactory: Growth of iron bacteria (clogs water system and bad odor)
Fluoride	2	Maximum
	>40	Unsatisfactory: Causes soft bones
Bacterial Coliforms	0 cfu/ml	Ideal: Levels above indicates fecal contaminations
Calcium	600	Maximum level
Sodium	50-300	Satisfactory: Generally no problem, however may cause loose droppings if sulphates >50ppm or if chloride >14ppm

NOTE: 1ppm approximates to 1mg

Courtesy of Dr Carlos Antonio Debortoli (2005)

If proper maintenance of the water line does not occur, microbial contamination can build up, affecting bird performance, reducing the effectiveness of medication and vaccination and reducing nipple flow rate. Implementing a regular water sanitation and line cleaning program will prevent the build up of microbial contamination. Controlling bacterial load is much more difficult with open drinker systems as they are exposed to contamination by fecal dust and the oral and nasal secretions of birds as they drink (Table 2). Closed nipple systems have the advantage of reducing disease spread, but even with these, dosing with a sanitizer that is effective in the presence of organic load and biofilm is regularly required. Chlorination to give between 3 and 5ppm at drinker level (using for example chlorine dioxide), or UV radiation are effective means of controlling bacterial contamination. Treatment should occur at the point of water entry into the house.

High levels of calcium salts or iron in the water may lead to the valves and pipes of the drinker system becoming blocked. Where this is a problem, it is advisable to filter the supply using a filter which has a mesh of 40-50 microns. For further information on water line sanitation programs, please refer to **Arbor Acres Update: Water Line Sanitation, August 2007**.

Table 2: Effect of Drinker Types on Water Bacteria Contamination (Micro-Organisms/ml of Sample). Adapted from Macari and Amaral, 1997.

Micro-Organisms	Nipple		Bell Drinker	
	Entrance*	End**	Entrance	End
Total Coliforms	640	3,300	1,600	1,700,000,000
Fecal Coliforms	130	230	1,000	80,000,000
Escherichia Coli	110	900	900	66,000,000
Fecal Streptococcus	55	1,200	2,000	36,000,000
Mesofiles Micro-Organisms***	24,000	700,000,000	86,000	1,400,000,000

NOTES

* Entrance means the first drinker in the chicken house.

** End means the last drinker in the chicken house.

*** Mesofiles Micro-Organisms – total count of saprophytes and pathogenic micro-organisms. The water was not treated.

Key Points

- A supply of clean, uncontaminated water should be freely available at all times.
- Regular assessments of water quality should be made to ensure microbial load and mineral content are within acceptable levels.

Conclusions

Water is an essential ingredient for life, a clean supply of which should be readily available from placement throughout production. Any restriction in water intake or contamination of water per se will ultimately affect the growth rate and overall performance of the bird. There are many factors that can affect water intake including age, sex, environmental temperature, water temperature and the drinker system type. The bacterial and physical quality of water should be monitored regularly and where required corrective action taken to ensure that bird performance is not compromised.

Key Points

- Unrestricted access to a source of good quality water at an appropriate delivery temperature (10-12°C) should be available.
- Provide adequate drinker space and ensure that drinkers are easily accessed by the whole flock.
- Monitor the feed to water ratio daily to check that birds are drinking sufficient water.
- Make allowances for increased water intake at higher temperatures (6.5% increase per degree over 21°C).
- In hot weather take steps to ensure that water is as cool as possible, e.g. flush drinker lines, use a cool pad, position tankers and drinkers underground or insulate.
- Regular testing of the water supply for temperature, bacterial load and mineral content should occur and where necessary the appropriate corrective action taken.



References

Bailey, M. 1999. *The water requirements of poultry. In Recent Developments in Poultry Nutrition 2* (ed J. Wiseman and P.C. Garnsworthy), pp 321-337. Nottingham: Nottingham University Press, UK.

Beker, A. and Teeter, R.G. 1994. *Drinking water and potassium chloride supplementation effects on broiler body temperature and performance during heat stress. Journal of Applied Poultry Research*, pp 87-92.

Macari, M. and Amaral, L.A. 1997. *Importancia da Qualidade da Agua Na Criacao de Frangos de Corte: Tipos, Vantagens e Desvantagens. Anais da Apinco Campinas*, pp 121-143.

National Research Council. 1994. *Nutrient requirements of poultry. 9th Rev. Ed. NAS-NRC, Washington, D.C.*

Singleton, R. 2004. *September issue. Hot weather broiler and breeder management. In Asian Poultry Magazine*, pp 26-29.

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