International Journal of Poultry Science 4 (10): 734-736, 2005
ISSN 1682-8356

A Survey of Common Practices in Shell Egg Processing Facilities and Water Use

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Abstract: Shell egg processing facilities in the U. S. were surveyed for common production practices and water use. Results were compiled and analyzed for frequency and significance via chi-square analysis. Of the respondents, 65.8 % utilized wells as their primary source of water. Furthermore, 19.2 % of the facilities discharged water to city sewers. Over half of the facilities processed 7 d each week with 8 to 9 h shifts ($P < 0.05$). There was a similar distribution of in-line, off-line and mixed operations represented in the responses. Two-thirds of the operations were dual washer systems with about half being plumbed separately. Over 90 % of the operations performed daily sanitation. Most facilities did not attempt to recycle water from their process. Fifty percent of the respondents utilized processing lines that are 5-15 yr old. The age of the processing line, number of processing days each week, size of facility and type of operation did not have a significant effect on water use.

Key words: Shell eggs, water, shell egg processing

Introduction

Water is critical for everyday activities. With the world's growing population, the need for water has become even greater. According to Byrnes (2002), the lack of clean water will be the biggest issue facing the world in the next 50 yr. Available fresh water accounts for about 1% of the earth's total water supply (www.factmonster.com, 2002). Global warming has also been predicted to have a detrimental effect on the availability of fresh water in the western United States (Bridges, 2002). With these issues in mind, it is no wonder water conservation has become such an important concern.

Water is a critical part in the processing of agricultural products. It is utilized to clean products, in processing technologies, to pump product during processing, clean equipment, as a coolant, an ingredient, etc. Shell egg processing is a typical example of water use to provide consumers with a safe product. An estimated 9.46 billion liters of wastewater are generated by the egg industry each year (Sheldon, 2002).

After the initiation of Hazard Analysis and Critical Control Point program (HACCP) in meat and poultry processing facilities, water use increased dramatically (Jackson and Curtis, 1998). For some poultry processing facilities, the increase in water use has been financially and environmentally taxing, leading to reductions in processing capabilities. While HACCP policies have not been regulated for the egg industry, food safety regulations are in the developmental stages. This survey was initiated to gain an understanding of how processing parameters affect water use in shell egg processing. An understanding of how and where water is being utilized in shell egg processing can allow for more efficient use of this natural resource.

Table 1: Percentage of respondents by region of the U.S.

Region	Percent of respondents
Central	20.8 %
North	30.6 %
Northeast	15.3 %
Southeast	15.3 %
West	18.0 %

Table 2: Percentage of respondents that utilized city water and city sewer, recycled water and had flat washing systems

	Yes	No	P value
City water[A]	32.9 %	65.8 %	0.0001
City sewer	19.2 %	80.8 %	0.0001
Recycled water	5.8 %	94.2 %	0.0001
Flat washer	45.2 %	54.8 %	

[A]One facility reported both city water and well water.

Materials and Methods

A twenty question survey was developed to determine average water use during shell egg processing and practices utilized by each facility. Attempts were made to fax or mail the survey to 236 shell egg processors in the U. S. Some facilities no longer process eggs or were only distributors. Replies were received by either fax or

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Table 3: Processing parameters and practices utilized by respondents

	In-line	Off-line	Mixed
Type of operation	43.1 %	23.6 %	33.3 %
	> 3000 cases/d	1500 - 3000 cases/d	≤ 1500 cases/d
Size of facility	27.4 %	37.0 %	35.6 %
	> 7.6 L/case	3.8 - 7.6 L/case	≤ 3.8 L/case
Water use	29.5 %	34.4 %	36.1 %
	> 9 h	8 - 9 h	< 8 h
Shift length(P < 0.05)	17.8 %	42.5 %	39.7 %
	> 15 yrs	5 - 15 yrs	≤ 5 yrs
Age of processing line (P < 0.01)	26.4 %	50.00 %	23.6 %
	Daily	Weekly	Never
Sanitation schedule (P < 0.0001)	92.8 %	4.4 %	2.8 %

Table 4: Average length of processing week among respondents (P < 0.0001)

Week length	Percent of respondents
4 d	2.8 %
5 d	20.8 %
6 d	12.5 %
7 d	63.9 %

Table 5: Processing line manufacturer utilized by respondents (P < 0.0001)

Line manufacturer	Percent of respondents
A	75.7 %
B	1.4 %
C	2.9 %
D	8.6 %
E	4.3 %
F	7.1 %

mail. Seventy-three completed surveys (30.9 %) were received. All responses were kept anonymous.

The data were compiled and categories (region, facility size, average water use, shift length, and average age of processing line) were established before analysis. Questions with a low percentage of responses were removed from analysis. Data were analyzed utilizing the frequency procedure of SAS (SAS Institute, 1999). Significance levels were determined by the chi-square operation or goodness-of-fit test. Chi-square, at the P < 0.05 level, determined if the relationship between two categories was significantly different (Northcutt and Jones, 2004).

Results and Discussion

Table 1 summarizes the percentage of respondents from various regions of the U. S. There was no difference in the frequency of respondents from each region. Of the respondents, 32.9 % purchased water from a municipality (P < 0.001) as seen in Table 2. Also, 19.2 % utilized municipal sewer systems (P < 0.0001). The greatest percentage of shell egg processors depend on ground water supplies for potable water. Furthermore, the majority of facilities must treat and dispose of wastewater. In view of this, it is important to note that 5.8 % of the respondents reported any form of water recycling procedures in place in their processing facilities (P < 0.0001). The use of flat washers in the facilities was not different among the respondents.

A summary of facility processing parameters is presented in Table 3. Respondents represented all forms of the industry, either in-line, off-line or mixed operations. The greatest number of respondents (72.6 %) produced fewer than 3000 cases per day. Of the respondents, 29.5 % utilized greater than 7.6 L of water per case of processed shell eggs. Most (36.1 %) of the facilities reported using less than 3.8 L of water per case of processed shell eggs. A majority of facilities (42.5 %) operated for 8-9 h processing shifts (P < 0.05), while 17.8 % of the respondents operating shifts greater than 9 h. The highest percentage of processing lines (50.0 %) were 5-15 yr old (P < 0.01). An additional 23.6 % of the processing facilities had lines less than 5 yr old. A significant (P < 0.0001) percentage of facilities performed daily sanitation procedures (92.8 %). Two facilities (4.4 %) reported weekly sanitation practices and another (2.8 %) stated that no sanitation procedures were utilized.

A majority (63.8 %) of the respondents processed eggs 7 d each week (Table 4, P < 0.0001). A 5 d work week was reported by 20.8 % of the facilities. Respondents reported using processing lines made by 6 different manufacturers (Table 5). A significant (P < 0.0001) number of respondents (75.7 %) utilized processing equipment from a single manufacturer. Most facilities (69.9 %) reported having dual washer systems (Table 6, P < 0.001). Of these dual washer systems, 47.1 % are plumbed jointly allowing water to flow between the two washers.

The distribution of facility size within the geographic regions was found to be significantly different (Table 7,

Table 6: Washing systems and dual washer plumbing utilized by respondents

	Dual	Single
Washer system (P < 0.001)	69.9 %	30.1 %
	Jointly	Separately
Washer plumbing	47.1 %	52.9 %

Table 7: Distribution of facility size within geographic regions of respondents (P < 0.05)

Region	> 3000 cases/d	1500 - 3000 cases/d	≤ 1500 cases/d
Central	4.2 %	9.7 %	6.9 %
North	16.7 %	8.3 %	5.6 %
Northeast	2.8 %	2.8 %	9.7 %
Southeast	2.8 %	9.7 %	2.8 %
West	1.4 %	6.9 %	9.7 %

Table 8: Plumbing of dual washer systems within geographic regions of respondents (P < 0.01)

Region	Jointly	Separately
Central	2.0 %	19.6 %
North	19.6 %	11.8 %
Northeast	9.8 %	2.0 %
Southeast	9.8 %	3.9 %
West	5.9 %	15.6 %

P < 0.05). The highest percentage of facilities producing greater than 3000 cases/d was in the North (16.7 %). The West region had the fewest (1.4 %) large size facilities respond to the survey. The Northeast and West regions each had 9.7 % of the survey respondents that produced fewer than 1500 cases/d. Regional preferences also existed for the plumbing of dual washer systems (Table 8, P < 0.01). The North, Northeast and Southeast regions had the greatest number of respondents with washers plumbed jointly. In the Central and West regions, washers had a greater frequency of being plumbed separately.

It is important to note the factors monitored in the survey that did not affect (P > 0.05) average water use during shell egg processing. Neither the region of the U. S. where the facility was located, size of the facility, nor type of operation affected average liters of water utilized to process a case of eggs. Water use was not influenced by the number of days each week a facility operated or by the length of the processing day. The age of the processing line and manufacturer of the equipment did not influence water use during processing. Neither dual nor single washer systems were a factor in average water use, nor was the plumbing (separately vs. jointly) of dual washer systems. The use of a flat washing system did not increase average water use. The frequency of complete sanitation processes also did not affect reported water use.

With the high percentage of facilities utilizing ground water supplies and disposing of wastewater themselves, it is important to consider the ecological and environmental aspects of such activities. In Nebraska, agriculture is the primary pollutant of water in the state, being responsible for 41 % of the water pollution (Henry and Franti, 2002). Reducing the water utilized during processing will help to decrease the economical and environmental burdens. Simple processing changes and proper equipment maintenance can greatly affect water use. Pollard (1998) stated that reducing the final sanitizing spray rate in shell egg processing from 16.72 L/min to 3.8 L/min would reduce water usage by 2.24 million L/yr. Therefore, options exist for the shell egg industry to decrease water use for processing.

Acknowledgments

The authors would like to thank Matt Savage for his assistance in completing this project.

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