THE HARMFUL EFFECTS OF ARSENIC-BASED FEED ADDITIVES IN POULTRY PRODUCTION

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I. INTRODUCTION

Chicken consumption in the United States has seen major increases.[1] Americans consumed twenty-eight pounds of chicken a year in 1960, but in 2005, the average American consumed eighty-seven pounds of chicken per year.[2]

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1. *See* Marian Burros, *Chicken With Arsenic? Is That O.K.?*, N.Y. TIMES, Apr. 5, 2006, *available at* http://www.nytimes.com/2006/04/05/dining/05well.html.

2. *Id.*

In response to these increases in consumption, poultry producers have instituted many changes to keep up with market demand. One such change deals with the feed used to produce these chickens.[3] The U.S. is the largest producer of animal feed in the world and produced over 120 million tons and exported nearly four billion dollars worth of feed ingredients in 2004.[4]

Feed additives, such as roxarsone,[5] have enabled poultry producers to increase production and lower costs.[6] In 2001, it took only forty-two to fifty-six days to raise chickens to market weight, which is a vast change from 1957, in which it took producers 103 to 105 days.[7] The broilers that are produced also weigh significantly more than in the past.[8] Despite these positives, there may be unforeseen costs with respect to production improvements, such as harmful health consequences resulting from exposure to these arsenic-based feed additives.[9]

This Note first provides a factual background of arsenic. It will briefly analyze the two types of arsenic commonly found in the poultry industry and describes the purpose of arsenic-based feed additives. Section III examines the health effects associated with arsenic and analyzes evidence suggesting that organic arsenic used in chicken feed becomes dangerous to human health when converted to inorganic arsenic through natural processes. Section IV analyzes studies which suggest that organic arsenic may convert into inorganic arsenic within the chicken. Section V critiques governmental regulation in the area of feed additives.

This Note then focuses on several studies that suggest an increased ingestion of inorganic arsenic results from the use of arsenic-based roxarsone in chicken feed by poultry producers. Section VII examines scientific evidence showing that organic arsenic transforms into inorganic arsenic in the litter and the resulting dangers of that transformation. Section VIII discusses Europe's stance

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3. Michael Greger, *Study Has many Clucking about Elevated Levels of Arsenic Found in Chicken*, FACTORY FARMING CAMPAIGN, Nov. 22, 2005, http://www.hsus.org/farm/news/ournews/arsenic_in_chicken_meat.html.

4. Amy R. Sapkota et al., *What Do We Feed to Food Production Animals? A Review of Animal Feed Ingredients and Their Potential Impacts on Human Health*, 115 ENVTL. HEALTH PERSP. 663, 663 (2007).

5. Bette Hileman, *Arsenic in Chicken Production: A Common Feed Additive Adds Arsenic to Human Food and Endangers Water Supplies*, 85 CHEM. & ENG'G NEWS 34, Apr. 9, 2007, *available at* http://pubs.acs.org/cen/government/85/8515gov2.html (discussing how roxarsone is the most common arsenic-based additive used in chicken feed).

6. Greger, *supra* note 3.

7. DAVID WALLINGA, PLAYING CHICKEN: AVOIDING ARSENIC IN YOUR MEAT 11 (2006), *available at http*://www.healthobservatory.org/library.cfm?RefID=80529.

8. *Id*.

9. Greger, *supra* note 3.

with regards to arsenic and organic chicken production. Section IX addresses opposing viewpoints and evidence. Ultimately, this Note concludes that due to increased arsenic exposure through use of roxarsone in chicken feed, the United States should follow Europe's lead and ban the carcinogenic substance from feed altogether.

II. USE OF ARSENIC IN FEED

A. *Definition & Classes of Arsenic*

Arsenic is a natural chemical element, steel grey in color with metallic properties that is widely distributed throughout earth's crust.[10] There are two forms of arsenic: organic and inorganic. Organic arsenic is arsenic combined with carbon or hydrogen, and inorganic arsenic consists of arsenic combined with elements such as oxygen, chlorine, and sulfur.[11] Scientists believe that inorganic arsenic is more dangerous to humans than organic arsenic.[12] Although inorganic arsenic is no longer allowed for use in agriculture, organic arsenic can be and is frequently used in feed additives.[13]

B. *Purpose of Arsenic in Feed*

Approximately seventy percent of the chicken broilers receive roxarsone in their diets.[14] Further, an estimated 2.2 million pounds of roxarsone have been given to chickens in the U.S. through poultry feed.[15] These arsenic-based additives are used for a number of reasons: to promote growth, kill parasites, and improve pigmentation.[16] Poultry producers seek to increase production and lower costs for increased profits, and feed additives enable them to do so. As previously mentioned, it now takes producers half the time that it took in 1957 to raise the chickens to market weight, largely because of the benefits of feed additives.[17] Further, the broilers that are produced today also weigh significantly more than

10. DIVISION OF TOXICOLOGY & ENVTL. MED., AGENCY FOR TOXIC SUBSTANCES AND DISEASES REGISTRY, PUBLIC HEALTH STATEMENT: ARSENIC CAS# 7440-38-2 § 1.1 (2007), *available at* http://www.atsdr.cdc.gov/toxprofiles/tp2-c1-b.pdf [hereinafter PUBLIC HEALTH Statement].

11. *Id*.

12. *Id*. at § 1.2, 1.3.

13. *Id*. at § 1.1.

14. Ben Harder, *Chicken Little? Study Cites Arsenic in Poultry*, SCIENCE NEWS, Oct. 25, 2003, *available at* http://sciencenews.org/view/generic/id/4366/title/Chicken_Little%3Fstudy_cites_arsenic_in_poultpo.

15. WALLINGA, *supra* note 7, at 13.

16. Hileman, *supra* note 5.

17. WALLINGA, *supra* note 7, at 11.

in the past.[18] Broilers now reach fifty percent greater weights in half the time that it once took before.[19] Despite all these positives for producers, there may be concerns for consumers.

III. Health Risks & Problems Associated with Arsenic Exposure

A. *Inorganic Arsenic*

There are numerous ways in which arsenic can affect human health. Inorganic arsenic can irritate a person's stomach and intestines, decrease blood cell production, cause fatigue and abnormal heart rhythm, damage blood-vessels, impair nerve function, and cause skin problems such as darkening, corns, and warts.[20] Inorganic arsenic has been identified as a human carcinogen by the Department of Health and Human Services and increases the risk of numerous types of cancer.[21] Large oral doses of inorganic arsenic are fatal.[22]

B. *Children*

Children experience many of the same health problems from arsenic as adults.[23] Evidence indicates that long term exposure to arsenic results in lower IQ scores.[24] Children may also be at a higher risk for arsenic exposure due to diet, behavior, and a lower efficiency at converting inorganic arsenic to organic arsenic.[25] Children eat lesser food varieties, consume dirt, and other materials containing arsenic, and may have difficulty converting inorganic arsenic to organic arsenic.[26]

C. *Organic Arsenic*

As of 2007, there was almost no information available regarding the health effects of organic arsenic on humans.[27] However, there have been animal

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18. *Id*.
19. *Id*.
20. Public Health Statement, *supra* note 10 at §1.5.
21. *Id*. (discussing how arsenic ingestion has been shown to increase risk of cancer of the liver, bladder, kidneys, prostate, skin, and lungs).
22. *Id*.
23. *Id*. at § 1.6.
24. *Id*.
25. *See id*.
26. *Id*.
27. *Id*. at § 1.5.

studies that reveal organic arsenic to be less toxic than inorganic arsenic.[28] Nonetheless, organic arsenic may still produce some of the health problems caused by inorganic arsenic if consumed in large doses.[29]

One such study, conducted by researchers from the National Institute of Environmental Health Sciences, exposed transgenic mice to various types and various amounts of arsenic through drinking water.[30] Regardless of whether the mice were exposed to inorganic or organic arsenic, the mice underwent numerous physical changes.[31] Inorganic and organic arsenic exposure increased mortality, decreased the body weight of the mice, induced hepatic pathological changes in the liver, and generated gene expression changes.[32]

Scientists also discovered differences in the impacts between inorganic and organic arsenic in the study.[33] In order to produce the similar effects of inorganic arsenic regarding toxicity and gene expression, organic arsenic was administered to the mice at doses five to ten times higher than that of inorganic arsenic.[34] Another difference is that while both types of arsenic produced affects on DNA hypomethylation in the liver, inorganic arsenic produced more hypomethylation than organic arsenic.[35] "DNA hypomethylation is an important mechanism involved in aberrant gene expression and carcinogenesis. In particular, it is thought that aberrant DNA methylation is central to the development of liver cancers . . . . "[36] This data supports the idea that while organic arsenic proves to be harmful, it likely produces less harmful effects on adults and children than inorganic arsenic.

IV. Conversion of Organic Arsenic into Inorganic Arsenic

Fortunately, seventy percent of broiler chickens are fed organic arsenic and not the more dangerous inorganic arsenic.[37] However, evidence suggests that

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28. *Id*.
29. *Id*.
30. Yaxiong Xie et al., *Biokinetics and Subchronic Toxic Effects of Oral Arsenite, Arsenate, Monomethylarsonic Acid, and Dimethylarsinic Acid in v-Ha-ras Transgenic (Tg.AC) Mice,* 112 ENVTL. HEALTH PERSP. 1255 (2004), *available at* http://www.ehponline.org/txg/members/2004/7152/7152.pdf.
31. *Id*.
32. Xie, *supra* note 30.
33. *Id.*
34. *Id*.
35. *Id*.
36. *Id*. (Citations omitted).
37. Hileman, *supra* note 5.

the organic arsenic commonly found in chicken feed converts into inorganic arsenic in the chickens under anaerobic conditions and in the environment.[38]

One study conducted by researchers from the Department of Plant and Soil Sciences of the University of Delaware, U.S. Geological Survey, and the Consortium for Advanced Radiation Sources and Department of Geophysical Sciences of University of Chicago observed arsenic in poultry excrement, also known as litter, and in soil collected from agricultural fields in Delaware using µ-SXRF analyses, µ-XANES analyses, and desorption method.[39] The researchers observed the XANES spectra of the arsenic and found that the arsenic in the chicken litter particles was different from the organic arsenic found in poultry feed.[40] This finding suggests that roxarsone may transform in the digestive tracts of the chickens or in the litter itself.[41] Despite the ban on the use of inorganic arsenic in poultry production, this data indicates that consumers may still be exposed to inorganic arsenic due to this transformation.

V. GOVERNMENTAL REGULATION

The U.S. Food and Drug Administration (FDA) is the agency charged with insuring that food and animal feed is safe.[42] Consequently, the FDA regulates use of arsenic in animal feed. The FDA sets specific tolerances for residues of arsenic in food for new animal feed drugs.[43] In edible tissues of chicken, the tolerance is 0.5 part per million in uncooked muscle tissue and 2 parts per million in uncooked edible by-products.[44]

The FDA also regulates roxarsone for use in animal feeds.[45] The FDA sets several guidelines for roxarsone in the amounts ranging from 22.7 to 45.4 grams per ton.[46] Chickens producing eggs for human consumption are prohibited from being fed roxarsone entirely.[47] The FDA requires broilers ingesting roxarsone to go through a withdrawal period of the roxarsone five days before being slaughtered.[48]

38. *Id*.
39. Yuji Arai et al., *Arsenic Speciation and Reactivity in Poultry Litter*, 37 ENVTL. SCI. & TECH. 4083, 4083 (2003).
40. *Id*.
41. *Id*.
42. 21 U.S.C. §341 (2006).
43. 21 C.F.R. § 556.60 (2008).
44. *Id*.
45. *Id*. § 558.530.
46. *Id*. § 558.530(d)(1).
47. *Id*.
48. *Id*.

Until the data study conducted by the Institute of Agriculture and Trade Policy in 2006, no research had been done to test the amount of arsenic in chicken muscle.[49] The research by the U.S. Department of Agriculture only evaluates arsenic in the chicken's liver and does not analyze arsenic in muscle tissue, despite its high consumption.[50]

In order to arrive at its conclusion that roxarsone is safe, the FDA analyzed data submitted by the manufacturers of the feed additives through new animal drug applications (NADAs).[51] According to NADA 141-100, the agency concluded that the data submitted by Alpharma, the drug's manufacturer, was within the "established safe concentrations in edible chicken tissues," but it would need to conduct and sponsor its own studies before qualifying for marketing exclusivity.[52] It is significant to note that it is the manufacturer who is responsible for conducting the testing and the studies.

The FDA has no way of knowing that these tolerances are being followed. "There are no pre-market reviews of approvals required of foods. Instead, manufacturers or distributors bear the burden of ensuring that any finished food placed on the market meets the safety levels implicit in the definition of adulterated foods."[53] While manufacturers may be concerned with food safety, a greater concern is to sell their product in order to increase profits, and food testing would increase production time and money.

Though the amount of chicken consumption by the average consumer has increased dramatically in the U.S. over the past fifty years, the FDA has not reassessed the arsenic levels it approved years ago.[54] This agency decision, heavily influenced by the industry it regulates, potentially leaves the American public exposed to hazardous levels of arsenic. The first study discussed in the next section finds that these tolerances may need to be reconsidered and reevaluated in light of the increase in consumption and other data.

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49. WALLINGA, *supra* note 7, at 5.

50. Ellen K. Silbergeld, *Arsenic in Food*, 112 ENVTL. HEALTH PERSP. A338, A339 n.6 (2004), *available at* http://www.thefreelibrary.com/Arsenic+in+food-a0117423248.

51. *See* FDA, FREEDOM OF INFORMATION SUMMARY: NADA 141-100 (1998), http://www.fda.gov/cvm/FOI/887.

52. *Id*.

53. Emily Marden, *Risk and Regulation: U.S. Regulatory Policy on Genetically Modified Food and Agriculture*, 44 B.C. L. Rev. 733, 746 (2003).

54. Burros, *supra* note 1.

VI. STUDIES SUGGEST INGESTION OF ARSENIC THROUGH CHICKEN CONSUMPTION

A. *The Lasky Study*

Researchers for the Office of Public Health and Science, a division of the USDA, conducted a study to estimate the amount of arsenic humans ingest through chicken consumption.[55] The researchers used data from the National Residue Program (NRP) in order to estimate the amount of arsenic in meat and poultry.[56] The NRP data consists of more than 20,559 analyzed samples comprised mostly of animal liver tissue.[57] The researchers estimated the concentrations of arsenic in muscle tissue by examining the data from the NRP and data on the ratio of arsenic concentrations in liver to muscle tissue presented by Alpharma.[58]

Additionally, the researchers used data from a study conducted in Canada for the inorganic and organic proportions of arsenic in chicken, as well as data from the USDA Economic Research Service for rates of chicken consumption in the U.S.[59] The samples in the Canadian study indicate that poultry consists of sixty-five percent of inorganic arsenic.[60] According to data reported by the USDA Economic Research Service in 2002, chicken consumption increased dramatically in the United States from an average of 40.1 pounds in 1970 to 71.8 pounds per year per person in 1997.[61] The mean level of consumption is approximately sixty grams per person per day.[62] Of the chicken consumed, the amount of young chicken consumed increased from ninety percent to over ninety-nine percent in that time period as well.[63]

The researchers grouped the samples into three categories consisting of nonquantified (undetectable), positive (detectable), and violative (above allowable levels) determined by the level of arsenic found in each sample.[64] Of the various poultry meats tested in the study, the greatest numbers of positive and viola-

55. Tamar Lasky et al., *Mean Total Arsenic Concentrations in Chicken 1989-2000 and Estimated Exposures for Consumers of Chicken*, 112 ENVTL. HEALTH PERSP. 18, 18 n.1 (2004).

56. *Id*.

57. *Id*.

58. *Id*. at 18-19.

59. *Id*. at 19.

60. *Id*.

61. *Id*.

62. *Id*.

63. *Id*.

64. *Id*.

tive samples were found in young chickens.[65] The researchers determined that the arsenic concentrations in young chickens were three times higher than all other meat and poultry samples tested.[66] Based on this data, they calculated that an individual ingests 1.38 to 5.24 micrograms of inorganic arsenic at the average rate of chicken consumption.[67]

The researchers made several important findings in this study. Arsenic concentrations were higher in poultry than other meat, which was consistent with the fact that there is arsenic in chicken feed.[68] Further, the researchers noted that some individuals consume chicken in much larger amounts than the mean.[69] One percent of the population consumes as much as 21.13 to 30.59 micrograms of inorganic arsenic through chicken consumption.[70] Ultimately, the researchers concluded that there is a need to reassess the estimates of ingested arsenic since data now indicates higher concentrations in chicken and because of the increases in chicken consumption.[71] Since these findings were published in 2004, the tolerances have yet to be changed by the FDA.

B. *Institute of Agriculture & Trade Policy Study*

Researchers for the Institute of Agriculture and Trade Policy (IATP) conducted a study to test the amount of arsenic in various samples of chicken meat.[72] The researchers tested 151 packages of chicken from supermarkets located in Minnesota and California, consisting of whole chickens, breasts, thighs, legs, and livers.[73] Chicken from five of the top twenty-five broiler producers were tested, as well as premium and organic chicken.[74] The IATP also tested ninety orders of chicken obtained from a wide variety of popular fast food restaurants in Minnesota and California, consisting of patties, strips, nuggets, and fried chicken.[75] These samples were obtained in November and December of 2004.[76] The prepared chicken samples were ordered without condiments and toppings, and once purchased, were sealed immediately in plastic bags and put on ice.[77]

65. *Id*.
66. *Id*. at 20.
67. *Id*. at 19-20.
68. *Id*. at 20.
69. *Id*.
70. *Id*.
71. *Id*.
72. WALLINGA, *supra* note 7, at 5.
73. *Id*. at 5-6.
74. *Id*. at 21.
75. *Id*.
76. *Id*. at 29.
77. *Id*.

Approximately five samples were tested of each product, which were purchased on the same day and from the same store or restaurant.[78]

The researchers used an Environmental Express Hot Block [79] in a process of heating and cooling in order for the samples to undergo a simulated digestion before testing.[80] Then Inductively Coupled Plasma Mass Spectrometry (ICPMS)[81] was used to measure the amount of total arsenic in the digested samples.[82] This process is capable of detecting total arsenic down to around two parts per billion, but the researchers sometimes used a detection level of only ten parts per billion first in order to lower costs.[83] If the arsenic level was below this detection level, the process was repeated with the two parts per billion detection level.[84] Although this was not an academic study, steps were taken to minimize biases and a margin of error was calculated and estimated to be between ten and twenty percent.[85]

The researchers found fifty-five percent of the chicken samples purchased from supermarkets contained detectable arsenic, while the remaining forty-five percent had no arsenic or arsenic below detection level.[86] The chicken sample with the highest levels of arsenic contained approximately twenty-one parts per billion.[87] The researchers found that only one-third of the organic, "premium" chicken parts or whole chickens had detectable arsenic levels,[88] while three-fourths of the samples that came from raw chicken breasts, thighs, and livers from conventional producers had detectable levels of arsenic.[89] The researchers also noted that not all "premium" brands tested better than non-premium brands.[90] Although three-fourths of the conventional producers contained detectable levels of arsenic, samples from two large broiler producers contained no

78. *Id*. at 21.

79. Environmental Express, Evaluation of the Hot Block Digestor for the Preparation of Environmental Samples for Trace Metal Analysis, http://www.envexp.com/news/articles/evaluation_of_the_hot_block_digestor_for_the_preparation_of_environmental_samples_for_trace_metal_analysis.asp (last visited Oct. 13, 2008).

80. WALLINGA, *supra* note 7, at 30.

81. University of Missouri-Columbia, Inductively Coupled Plasma Mass Spectrometry (ICP-MS), http://web.missouri.edu/~errantec/cme/pages/ac_icpms1.shtml (last visited Oct. 13, 2008).

82. WALLINGA, *supra* note 7, at 30.

83. *Id*.

84. *Id*.

85. *Id*.

86. *Id* at 6.

87. *Id*. at 22.

88. *Id*. at 6 ("Use of arsenic in chicken feed is prohibited under organic standards.").

89. *Id*.

90. *Id*. at 7.

detectable levels of arsenic on average.[91] These findings "strongly suggest that different broiler chicken producers use arsenic very differently."[92]

The researchers also found the levels of arsenic in the fast food restaurant samples varied greatly as well.[93] While arsenic was detected in all samples, there was a vast difference in the amount of arsenic found between the samples.[94] The highest level of arsenic in the chicken samples contained 46.5 parts per billion, while the lowest contained only 2.2 parts per billion of arsenic.[95] The researchers concluded that, even though this variance could be explained by differences in preparation or cooking, another explanation could be that some of the chickens were raised with arsenic feed additives, while others were not.[96] Based on the fact that the researchers found a great disparity in arsenic levels between the samples collected from both the supermarkets and fast-food restaurants, it can be concluded that poultry farmers utilize a variety of production methods.

C. *Other Research*

Dr. Ellen Silbergeld of Johns Hopkins University scrutinized the Lasky Study and concluded that the amount of arsenic intake through poultry consumption is likely higher than the study's figures.[97] One reason for this underestimation is that Lasky and the other researchers were limited with regards to data, since the USDA does not test the arsenic levels in muscle, and Dr. Silbergeld contends that arsenic concentrations are higher in muscle tissue.[98] Additionally, the researchers used data of arsenic concentrations found in livers and then converted these figures to concentrations found in muscle using a liver-to-muscle ratio.[99] Another reason for this undervalue of arsenic intake is due to the use of a twenty year old human health assessment.[100]

Silbergeld also looked at a study examining the metabolism of arsenic in mammals.[101] The researchers found arsenic concentrations to be higher in muscle than in the livers after repeated arsenic exposure.[102] Based on these findings and

91. *Id*. at 6-7.
92. *Id*. at 22.
93. *Id*. at 7.
94. *Id*.
95. *Id*. at 24 fig. G.
96. *Id*.
97. Silbergeld, *supra* note 50, at A339.
98. *Id*.
99. *Id*.
100. *Id*.
101. *Id*.
102. *Id*.

the concerns of the Lasky Study, Silbergeld concluded that arsenic consumption is indeed much higher.[103]

VII. Conversion of Organic Arsenic into Inorganic Arsenic in the Litter

Researchers Brian Jackson and Paul Bertsch recognized the potential dangers of spreading poultry litter containing arsenic to fields, so they conducted a study to generate a methodology so that p-arsanilic acid (p-ASA) and roxarsone (ROX) in poultry litter and soil could be separated and quantified.[104] Once Jackson and Bertsch generated a methodology, they applied it and found roxarsone was the primary As species.[105] They also observed that arsenic in poultry litter was highly water soluble.[106]

Jackson and Bertsch conducted a subsequent study with other researchers examining the concentration and solubility of arsenic and the formation of a new species of arsenic in the poultry litter.[107] The researchers found the concentration of arsenic in the litter to range from approximately one to thirty-nine mg kg^{-1}.[108] They also found arsenic to be highly water soluble with a water-soluble extract value of seventy-one percent.[109] The litter was found to consist mostly of ROX and of As(V), or inorganic arsenic.[110] They discovered a negative correlation between ROX and As(V) which indicates that As(V) is a major degradation product of ROX.[111] This research illustrates the organic arsenic's transformation to the more dangerous inorganic arsenic.[112] The researchers also concluded that ROX not only transforms into As(V) but also into an unidentified species of arsenic.[113]

Researchers from Johns Hopkins University in Maryland examined the potential dangers and problems with the use of arsenic in poultry feed.[114] Due to

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103. *Id*.

104. Brian P. Jackson & Paul M. Bertsch, *Determination of Arsenic Speciation in Poultry Wastes by IC-ICP-MS*, 35 ENVTL. SCI. & TECH. 4868, 4868 (2001).

105. *Id*. at 4872.

106. *Id*.

107. Brian P. Jackson et al., *Trace Element Speciation in Poultry Litter*, 32 J. ENVTL. QUALITY. 535, 536 (2003), *available at* http://jeq.scijournals.org/cgi/reprint/32/2/535.

108. *Id*. at 537.

109. *Id*. at 538.

110. *Id*.

111. *Id*. at 539.

112. *Id*.

113. *Id*.

114. Keeve E. Nachman et al., *Arsenic: A Roadblock to Potential Animal Waste Management Solutions*, 113 ENVTL. HEALTH PERSP. 1123, 1123 n.9 (2005).

the abundance of broilers produced annually in the United States, approximately 250,000 to 350,000 kilograms of arsenic is applied to land.[115] Since evidence suggests that the organic arsenic in litter transforms into more hazardous inorganic arsenic, this poses problems because arsenic is leachable and therefore can move into groundwater.[116] Increased levels of arsenic in groundwater results in increased human exposure, and increased human exposure results in an increased risk of health dangers, such as cancer.[117]

Due to the abundance of waste, alternative waste management practices are being used, such as incineration.[118] The resulting ash is then sold off as fertilizer.[119] Litter is also distributed in the form of dried pellets to be used in landscaping and gardening.[120] These disposal methods "may well increase human exposures to arsenic either through air emissions from waste-to-energy plants or through contamination of soils, water, and food crops. . . ."[121]

This issue was further evaluated through a study that examined dust from homes located near chicken farms.[122] The researchers concluded that these homes contain elevated levels of arsenic.[123] To further support this assertion, residents of the Lower Shore in Maryland exceed the national averages for cancer rates.[124] Poor diet and poor health insurance have been suggested as possible explanations however it should be noted that 338,679 tons of litter is produced every year in Maryland.[125]

Dr. Basu also investigated the effects of roxarsone on human blood vessels.[126] Chickens exposed to roxarsone experience angiogenesis,[127] and Basu discovered that humans experience the same effect.[128] This is important information because the growth of blood vessels occurs in the beginning phases of numerous

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115. *Id*.
116. *Id*.
117. Don Hopey, *Chicken Feed Additive May Pose Danger*, PITTSBURGH POST-GAZETTE, Feb. 7, 2008.
118. Nachman, *supra* note 114, at 1123.
119. *Id*.
120. *Id*.
121. *Id*.
122. Hopey, *supra* note 117.
123. *Id*.
124. John Vandiver, *Arsenic:Chicken Feed Effects Questioned*, THE DAILY TIMES (Maryland), Jan. 4, 2004, *available at* http://www.mindfully.org/Farm/2004/Arsenic-Chicken-Roxarsone4jan04.htm.
125. *Id*.
126. Hopey, *supra* note 117.
127. *Id*.
128. *Id*.

diseases.[129] In summary, evidence demonstrates that organic arsenic in the chicken litter transforms into inorganic arsenic, and the dispersal of this dangerous substance into the environment increases exposure and consequently could lead to harmful health risks.

VIII. CHICKEN PRODUCTION WITHOUT ARSENIC

An enormous amount of arsenic is used annually in broiler feed; however, it is not necessary. Europe has banned use of arsenic-based feed additives.[130] Organic chicken producers here in the U.S. are also prohibited from using arsenic in poultry feed.[131]

A. *Europe's Approach*

Before veterinary medicinal products can be used for food producing animals, a safety and residue evaluation is performed by the Committee for Medicinal Products for Veterinary Use (CVMP) of the European Medicines Agency (EMEA).[132] The CVMP will then issue an opinion and recommendation for the product with regards to maximum residue limits (MRLs) and inclusion of the substance in one of the Annexes maintained by CVMP.[133] If there are questions as to a product's safety, a MRL will not be established, "as it must be assured that residues at the proposed levels do not present a hazard to the health of the consumer."[134]

The CVMP will sometimes refrain from providing a recommendation because there is a lack of information available for their researchers to reach a conclusion.[135] On January 14, 2004, the CVMP decided that it could not make an MRL recommendation for roxarsone.[136] Since a safe roxarsone MRL could not be determined, roxarsone cannot be used for food producing animals in Europe.[137]

129. *Id*.
130. WALLINGA, *supra* note 7, at 9.
131. *Id*. at 6.
132. European Medicines Agency, Status of MRL Procedures: MRL Assessments in the Context of Council Regulation (EEC) No. 2377/90 of 29 July 2008 1, *available at* http://www.emea.europa.eu/pdfs/vet/mrls/076599en.pdf [hereinafter Status of MRL Procedures].
133. *Id*. at 2.
134. *Id*. at 1.
135. *Id*. at 2.
136. European Medicines Agency, Summary Opinion of the Committee for Veterinary Medicinal Products on the Establishment of Maximum Residue Limits: Roxarsone of 14 January 2004, *available at* http://www.emea.europa.eu/pdfs/vet/mrls/mrlopinions/008304en.pdf.
137. *See* Status of MRL Procedures, *supra* note 132, at 16.

B. *Organic Chicken Production*

As previously stated, arsenic is not essential to the production of poultry. Some poultry producers practice organic chicken production. "Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."[138] The USDA organic standards were established through the National Organic Program (NOP) by the Secretary of Agriculture with the assistance of the National Organic Standards Board (NOSB) and outline the various requirements for organic producers to follow.[139] In order for a product to carry the USDA organic seal, the farm must first be inspected to make sure that all appropriate USDA organic standards are being followed by the producer.[140]

The NOP includes a multitude of requirements.[141] For example, section 205.239 of the NOP outlines the requirement that organic livestock must have access to the outdoors, fresh air, and sunlight.[142] Section 205.237 of the NOP outlines the standards for livestock feed, and one such requirement is that the producer may not administer animal drugs or hormones.[143] Also, there is a National List of Allowed and Prohibited Substances that organic producers must abide by.[144] Most importantly, section 205.602 of the NOP lists the non-synthetic substances prohibited for use in organic crop production, one of which is arsenic.[145] Consequently, the popularly-used feed additive roxarsone is prohibited from organic poultry production. The production practices of Europe and the organic chicken producers here in the U.S. clearly illustrate how arsenic is an unnecessary substance in accomplishing successful poultry production.

138. Mary V. Gold, USDA, Organic Production/Organic Food: Information Access Tools (June 2007), http://www.nal.usda.gov/afsic/pubs/ofp/ofp.shtml.

139. Bob Buresh, Certified Organic Poultry Production, http://www.ces.ncsu.edu/depts/poulsci/conference_proceedings/nutrition_conference/2003/buresh_2003.pdf (last visited Oct. 13, 2008).

140. USDA, Organic Food Standards and Labels: The Facts, http://www.gulfbend.org/poc/view_doc.php?type=doc&id=9679&cn=281 (last visited Oct. 13, 2008).

141. *See* Buresh, *supra* note 139.

142. *Id*.

143. *Id*.

144. USDA, Applicability Preamble, http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3003491&acct=noprulemaking (last visited Oct. 13, 2008).

145. The National List of Allowed and Prohibited Substances, 7 C.F.R. § 205.606 (2007).

IX. OPPOSING VIEWPOINTS

Even though it appears the weight of the evidence supports banning the use of arsenic in poultry feed, the issue remains controversial. The National Chicken Council (NCC) takes the position that IATP's report on the subject is unscientific and ignores the fact that humans are exposed to arsenic in many other ways.[146] The NCC argues that arsenic-based feed additives contribute to a healthy food supply and that there is no evidence to suggest that this use poses health concerns.[147] The NCC stated "[r]ather than us[e] a scientific method, IATP clearly decided on its conclusion first and then went out to look for the data."[148] The NCC also claimed that the organic form of arsenic used is less dangerous than inorganic arsenic and is FDA-approved.[149] The NCC further stated that arsenic found in chicken meat may be present due to naturally occurring arsenic in the environment.[150]

Also, toxicologist Bruce Bernard finds researcher Dr. Ellen Silbergeld's conclusions to be "her personal opinions and not a scientific conclusion based on sound methodology and evidence."[151] Bernard stated that Silbergeld misused information from the Lasky Study and remedying this error would contradict her conclusion that chicken consumption would significantly contribute to inorganic arsenic intake acquired through water consumption.[152] Silbergeld responded to these assertions by stating that even though she used the wrong metric, her conclusions and findings are still supported by evidence.[153]

Data produced by Alpharma also presents contradictory evidence.[154] Alpharma claims that its roxarsone feed additive, 3-Nitro, does not significantly increase the amount of arsenic in chicken meat and that arsenic levels in the chickens are below the FDA's allowable levels.[155] Alpharma also points out that

146. *See* Tim Lundeen, *Arsenic Paper Refuted*, AG OBSERVATORY, May 22, 2006, http://agobservatory.org/headlines.cfm?refID=87920.

147. *Id*.

148. *Id*.

149. *Id*.

150. *Id*.

151. Bruce K. Bernard, Op-Ed, "*Arsenic in Food": Opinion Parading as Science*, 113 ENVTL. HEALTH PERSP. A224, A225, *available at* http://www.thefreelibrary.com/%22Arsenic+in+food%22:+opinion+parading+as+science.-a0132226964.

152. *Id*.

153. Michael Sperling, *Conflict Raised in Chicken Arsenic Debate*, EVISA NEWS, Apr. 27, 2005, http://www.speciation.net/Public/News/2005/04/27/1432.html.

154. *See* Alpharma, Technical Bulletin, 3-Nitro is Safe for the Consumer and Environment (1999), *available at* http://www.alpharma.com/newahd/pages/getfile.aspx?m=view&id=%5C%5CPdf%5CTechbullpdf%5Ctechb1___v1.0.pdf.

155. *Id*. at 1-2.

these arsenic allowable levels developed by the FDA are lower than the allowable levels designated for seafood.[156]

Additionally, Alpharma claims that data from a study conducted in Arkansas in the 1960s "strongly support that roxarsone in poultry litter applied to fields has no detectable impact on the environment even after twenty years of use."[157] The researchers in this study compared soil from fields that were never treated with litter with fields treated with litter from chickens fed 3-Nitro.[158] They found that the levels of arsenic between the fields did not differ significantly.[159]However, Alpharma is a major producer of pharmaceuticals and has a strong interest in the continuing use of roxarsone in poultry feed. Also, Alpharma based these assertions on a study conducted over thirty years ago.[160]

Australian researchers, who have also studied the safety of poultry meat in their country, are another source of disagreement.[161] The researchers evaluated chemical food safety hazards and discovered ways in which these hazards could be remedied.[162] The researchers assessed fifteen contaminants, including arsenic, due to the use of arsenic based anticoccidials by producers.[163] The researchers found that "[a]rsenic dietary exposure from the consumption of poultry meat products present a negligible risk to the consumer," with poultry products contributing only 2.36 percent of a person's daily total inorganic arsenic intake.[164]

Also, researchers from the Department of Chemistry at Norwegian University of Science and Technology evaluated the history of arsenic use and arrived at the conclusion that arsenic may be an essential mineral.[165] Arsenic is now seen as a poison, but as early as 2000 B.C.E., it was used for a number of diseases and ailments, and arsenic is still used to for treatment today.[166] The re-

156. *Id*. at 2.
157. *Id*.
158. *Id*.
159. *Id*.
160. *Id*.
161. *See* FOOD STANDARDS AUSTRALIA NEW ZEALAND, SCIENTIFIC ASSESSMENT OF THE PUBLIC HEALTH AND SAFETY OF POULTRY MEAT IN AUSTRALIA 6 (2005), *available at* http://www.foodstandards.gov.au/_srcfiles/P282_Poultry%20_%20DAR%20Attach3.doc.
162. *Id*. at 1.
163. *Id*. at 151-52.
164. *Id*. at 154.
165. *See* Annette Lykknes & Lise Kvittingen, *Arsenic: Not So Evil After All?*, 80 J. CHEM. ED. 497, 497 (2003), *available at* http://66.102.1.104/scholar?hl=en&lr=&q=cache:XJdhKCYq7k4J:jce.chem.divched.org/hs/Journal/Issues/2003/May/clicSubscriber/V80N05/p497.pdf+chicken+feed+history+weight+growth+parasites+arsenic.
166. *Id*. at 497.

searchers also stated that "[t]he addition of arsenic compounds to animal feed yielding good results supports the postulate of arsenic as an essential mineral."[167]

X. CONCLUSION

The proponents of roxarsone suggest that people are primarily exposed through the environment and not through chicken consumption, and that poultry producers use less harmful, organic arsenic. However, as this Note has discussed, the organic arsenic is converted into inorganic arsenic, and the process produces substantial amounts of arsenic through the chicken litter. Simply because arsenic already exists in the environment does not mean that increased arsenic output should not be avoided. Even if further research proves that people are not exposed to increased levels of arsenic through chicken consumption, they still face increased levels of exposure from the litter through other avenues, such as arsenic traveling into the groundwater.

The majority of the researchers and authors discussed in this Note have stressed the need and importance of further studies. Research that explores the levels of arsenic ingested in the muscle of the chicken, as well as the types of arsenic ingested, is necessary. It was previously discussed that the USDA assumes that the levels of arsenic in the chicken muscle are within the appropriate limits based on tests conducted on chicken livers. This is a very dangerous assumption to be made when dealing with the exposure of carcinogenic arsenic. After conducting her study, Lasky found that "there's very little known about the effects of cooking, digestion, and metabolism on the arsenic that is in chicken."[168] Due to this uncertainty, the CVMP does not allow poultry producers to use roxarsone and other arsenic-based feed additives in Europe.[169] Until researchers ascertain all the necessary information regarding this issue, the United States should follow Europe's lead and ban the use of arsenic in poultry feed altogether.

167. *Id*. at 499.

168. Karen Lurie, *Arsenic Chicken*, SCI. CENT. NEWS, Feb. 24, 2004, http://www.sciencentral.com/articles/view.php3?article_id=218392183&cat=1_6.

169. WALLINGA, *supra* note 7, at 18.