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A survey of commercially available broilers originating from organic, free-range and conventional production systems for cooked meat yields, meat composition and relative value

Abstract: The project analyzed meat from broilers raised in three production systems to determine how they differed in terms of cost, yield, and various chemical and sensory qualities.

Question & Answer

Q: Why were organic, free-range and conventionally-raised broilers compared for meat yield and composition?

A: There is a very large price premium currently paid for organic and free-range broilers and this study was intended to provide insight on the reasons for the price premiums. The results showed that the broilers do not differ greatly in composition or eating quality, and consequently the price premiums are probably the result of consumer perceptions of the environmental and animal welfare advantages associated with organic and free-range production systems.

Organic poultry production must follow USDA certification guidelines that include using organic feed, omitting use of antibiotics, providing access to the outdoors, and receiving agency approval for the premises where the poultry are raised. Free-range poultry production requires outdoor access for the birds, but is not as constrained as organic production in the use of inputs and guidelines related to feed, antibiotic use, and housing certification. Consumer purchases of poultry products are determined by factors such as wholesomeness, quality, class, nutritive value, and informational labeling.

The objective of this survey was to investigate qualitative and quantitative properties of meat from organic, free-range, and conventional broilers as marketed to the general consumer.

Background

The U.S. Department of Agriculture approved a USDA Certified Organic label with specific requirements for organic products in late 2001. This provided significant incentive for producers to market organically-raised products, including poultry. Free-range poultry products that are not raised according to organic standards cannot carry the USDA certification label, but they still command a premium price for using a production method that consumers may deem friendlier to animal welfare and environmental quality. Sales of organic and free-range poultry have increased dramatically in the last decade.

Approach and methods

Fifteen whole broilers with a target weight of 4.5 to 5.5 pounds were obtained from four suppliers each of organic, free-range, and conventional broilers. The broilers were purchased from retail stores or processors, thereby providing a representative sample of what would be available to the general consumer. Chickens were purchased frozen or were frozen immediately after delivery to the ISU Meat Laboratory. Seven of the 15 chickens from each supplier were used for sensory analysis, while the remaining eight were used for physical and chemical analyses. These eight chickens were divided into two groups of four, one for raw product analyses and the other for cooked product testing.

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Raw chickens were evaluated for color, pH, carcass component yield, degree of oxidation, proximate analysis, and fatty acid profile. Cooked chickens were evaluated for color, carcass component yield, degree of oxidation, proximate analysis, cooking yield, and shear force tenderness values.

Among the basic items the investigators considered in their analyses were:

- Carcass component yield
- Cooking yield
- Proximate analysis
- Color
- pH (to assess muscle moisture retention capacity and biochemical factors that affect meat quality)
- Thiobarbituric acid reactive substances (TBARS)
- Fatty acid profile
- Tenderness
- Trained panel sensory analysis

Results and discussion

On a raw basis, organic broilers yielded a higher percentage of dark meat and a lower percentage of skin than free-range or conventional broilers. On a cooked basis, conventional and free-range broilers yielded a higher percentage of cooked light meat than organic broilers. Free-range whole carcasses had the highest total cooked yield, however, this was significant only in comparison to conventional broiler yields. Protein content of raw organic breast and thigh meat was greater than conventional broilers, but not different than free-range broilers. The protein content of cooked organic breast and thigh meat also was greater than conventional, consistent with analyses on the raw basis comparisons. While the cooked protein content was greater in the organic broilers by 1.5-2.8 percent, this is a relatively small difference compared with the 2.47 times greater price for the organic broilers over conventional broilers. Therefore, the conventional broilers represent the cheapest source of protein of the three types of broilers compared.

Ultimate pH (pHu) for breast meat from organic broilers was higher when compared to free-range and conventional. The pHu of organic thigh meat, however, was higher than the free-range, but not conventional broilers. Raw organic breasts and thighs were lighter and less yellow in

color when compared to free-range and conventional. Consistent with raw color value trends, cooked color values for organic and free-range breast, thighs, and skin remained less yellow compared to conventional parts. Thiobarbituric acid reactive substances (TBARS), which indicate rancidity and off-flavor, were lower for raw free-range breasts and thighs than for organic or conventional birds. Fatty acid analysis showed that organic breasts and thighs were lower in saturated and monounsaturated fatty acids and higher in polyunsaturated, omega-3, and omega-6 fatty acids compared to free-range and conventional birds. Results from the trained sensory panel indicated that conventional thighs were more tender and less chewy than thighs from free-range and organic broilers. Other sensory parameters were not significantly different among the attributes tested for breasts or thighs.

When the broilers were obtained for the study (March through May 2006), the average retail prices for whole broiler chickens (averaging all four brands per type) were \$3.19, \$2.78, and \$1.29 per pound for organic, free-range, and conventional whole broilers, respectively. While the fatty acid composition appears to be the largest difference observed between retail whole broilers for the evaluations conducted, it is important to note that the diets were not controlled for the birds within the study. It is apparent that consumers are willing to pay a premium price for product characteristics beyond those evaluated in this study, and may place significant value on more intangible attributes associated with production of organic and free-range chicken.

Conclusions

The most significant differences among organic, free-range and conventional chickens observed in this study included color, fatty acid composition, and tenderness. Conventionally raised chickens consistently demonstrated a more yellow appearance for breast, thigh and skin pieces when compared to organic and free-range carcass components. Organic chicken breasts and thighs had significantly higher percentages of polyunsaturated fatty acids, including omega-3 and omega-6 fatty acids compared to free-range and conventional chickens. This may be of particular value to consumers who are concerned about fats and healthfulness of saturated vs. unsaturated fatty acids. It may be part of the perceived advantages that result in premium prices charged for

Table 8. Comparison of Organic, Free-Range and Conventional Sources of Chicken Meat for Differences in Lipid Characteristics

Fatty Acids (% of total fatty acids)	Organic	Free Range	Conventional	±SEM
Saturated	30.14a	32.46b	32.31c	0.30
Monounsaturated	31.67a	38.82b	39.13c	0.87
Polyunsaturated	38.19a	28.72b	28.57b	0.78
Omega 3	3.92a	2.93b	1.93c	0.14
Omega 6	34.28a	25.79b	26.64b	0.67

*Means in the same row with different letters are significantly different (P<0.05).

Table 9. Cooked Breast and Thigh Tenderness Values

Tenderness (kg/cm ²)	Organic	Free Range	Conventional	±SEM
Breast	2.70a	3.00b	2.42c	80.87
Thigh	1.88a	1.89a	1.45b	66.40

*Means in the same row with different letters are significantly different (P<0.05).

Table 2. Raw and Cooked Breast, Thigh and Skin Proximate Analyses

Proximate Analysis (%)		Organic	Free-Range	Conventional	±SEM	
Raw	Breast	Fat	2.08a	1.80a	1.92a	0.12
		Moisture	74.98a	74.81a	75.52b	0.15
		Protein	23.31a	23.26a	22.26b	0.15
	Thigh	Fat	7.16a	7.23a	5.92a	0.51
		Moisture	73.99a	73.22a	72.56a	1.00
		Protein	19.25a	19.49a	17.82b	0.34
	Skin	Fat	28.24a	42.32b	41.42b	1.36
		Moisture	52.54a	44.21b	45.91b	1.06
		Protein	12.88a	10.88b	9.70b	0.39
Cooked	Breast	Fat	3.31a	3.95a	4.78b	0.20
		Moisture	71.04	70.89	70.89	0.30
		Protein	26.95a	26.74a,b	25.37b	0.46
	Thigh	Fat	6.98a	8.24b	8.73b	0.36
		Moisture	69.16a	69.68a	69.93a	0.33
		Protein	24.62a	22.85b	21.85b	0.46
	Skin	Fat	24.13a	28.23a	27.31a	1.34
		Moisture	54.65a	48.07b	52.47a	1.22
		Protein	12.49a	10.66b	11.01b	0.27

*Means in the same row with different letters are significantly different (P<0.05).

these products. Alternatively, instrumental measurements as well as sensory evaluations found that thighs from conventional broilers were judged to be more tender than those of organic and free-range chickens.

Consumer demand is increasing for both safe and wholesome foods and for assurance of acceptable methods by which these foods are grown. The recorded retail prices indicated a large variance among the three consumer sources of chicken compared in this survey. It would appear that the premium prices that consumers are willing to pay for organic and free-range chicken involve more than the measurable differences in quality and quantity of meat, at least for those properties measured by this study.

Impact of results

The results of this survey indicate that quantitative differences between natural, organic and conventional broilers are limited and in most cases, insignificant, at least for those properties measured in this study. The biggest exception was for fatty acid profiles which were measurably different for the organic broilers. Consumers appear to be differentiating the value of production

systems for broilers more on concepts and preferences based on their perceptions of the products and the production system than on quantitative differences in the products themselves.

Education and outreach

Publications from this project include a M.S. thesis by Ryan Husak (A Survey of Yields and Quality Attributes of Meat from Broilers Produced for Organic, Free-Range and Conventional Marketing), an Animal Industry Extension Report (A.S. Leaflet R2222), and a manuscript that is in preparation to be submitted to the *Journal of Poultry Science*. No outreach programs were conducted as a result of this work. One graduate student (Ryan Husak) was supported by this project.

A presentation on the project is available on the Leopold Center web site: http://www.leopold.iastate.edu/research/marketing_files/workshop06/presentations/poultry.pdf

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No additional funds were leveraged by this project.

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