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Livestock Research

Nutrient composition of poultry from different farms and management systems

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In a Nutshell

- Interest in pasture-raised livestock has risen in part because of health benefits to the animals and to the consumer.
- Raising poultry on pasture allows the birds to express natural behaviors, exercise, and increase intake of green plants, which alters fatty acid composition.
- The macronutrient, mineral, and fatty acid composition was determined for ten fryer chickens from five pasture-based farms and two fryers from the Hy-Vee brand label.
- Birds from different farms differed in content of protein, potassium, magnesium, phosphorus, sulfur, zinc, and several fatty acids.
- Project results, and other research suggest it is possible to influence poultry meat nutrient content.

Interest in pasture-raised poultry has risen in part because it allows the birds to express natural behaviors and forage, which alters fatty acid compostition and may provide health benefits to the consumer.

Background

Consumer preferences are shifting towards grass- and pasture-based meats, due to perceived benefits for the environment, local economy, welfare of the animals, and consumer health. Allowing poultry access to grass gives them freedom to express natural behaviors and to forage for some of their diet. This not only provides environmental enrichment but nutritional benefits: while chickens cannot survive on grass alone, ingesting green forages has been demonstrated to increase the amount of "healthy" fats in the chicken fat (Garcia, 2011; Ponte et al., 2008a; Ponte et al., 2008b). In addition, some studies have demonstrated improved weight gain and efficiency when broilers were given access to forage as well as a cereal diet (Ponte et al., 2008a), but some uncertainty exists regarding the impacts of pasture. Many PFI farmers pasture-raise their birds to garner these benefits. The present study was designed to explore the nutrient content of a variety of farms' birds compared to those found at a commercial grocery store.

Methods

Six farms donated two fryer chickens each for the study and two were purchased from a HyVee, Inc. grocery store. All were sent to Iowa State University for further processing and analysis in the lab of Dr. Mike Persia. Carcasses were split into left and right halves; boneless, skinless breasts and bone-in, skin-on thighs were collected from each side. Right side samples were cooked at 350°F for 45 min (breasts) or 60 min (thighs), while left side samples were left raw. All samples were freeze-dried before analysis to equalize moisture content.

Samples were analyzed for content of crude protein, ash, fat, and various minerals: calcium, copper, iron, potassium, magnesium, manganese, sodium, phosphorus, sulfur, and zinc. Thighs were also tested for fatty acid content (given as a % of total fat). Values reported are means of the two birds from each farm, either in percent of dry matter (macronutrients) or ppm (micronutrients).

Data Analysis

Values from the two birds from each source were averaged. Data was analyzed using SAS 9.3 (SAS Institute Inc., Cary, NC) and nutrient comparisons employ least squares means for accuracy. Statistical significance was determined at α=.05 level

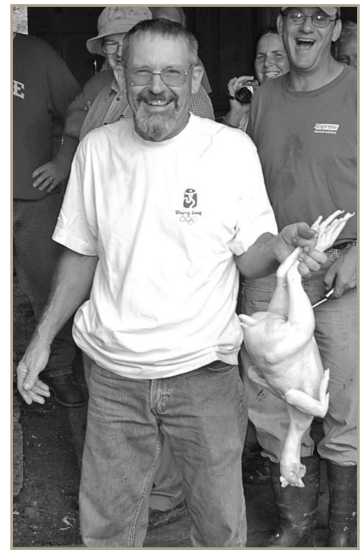
Results and Discussion

Due to the low number of replicates and some failed lab analyses, statistical significance could not be established between management types or individual farms. Averages for the conventional and the pasture farms are shown separately; while there are clear numeric differences, the two are not statistically different.

Macronutrients: Protein, Ash, and Fat

Table 1 shows the average protein, ash, and fat content of all breasts, all thighs, and then both samples for the conventional, pasture, cooked, and uncooked samples. Crude protein differed between breasts and thighs, being greater in breasts ($P < 0.01$). Conversely, fat was lower in breasts than in thighs, as expected ($P < 0.01$). Protein and fat were also different between cooked and uncooked samples ($P = 0.0001$ and 0.0004); while protein increased proportionally when the meat was cooked, fat decreased. Protein content differed between individual farms ($P = 0.0004$), but again it cannot be determined which farms were significantly different from one another. An interaction was observed between cooking and the piece tested, for both protein ($P = 0.0224$) and fat ($P = 0.0026$). This means that the effect of cooking on the protein or fat content of the breast was not the same as the effect of cooking on the thigh. Ash content was similar in all samples ($P > 0.10$), regardless of the farm of origin, whether it was cooked or not, or the cut of meat. Ash content is not expected to differ much—it measures mostly minerals and other noncombustible portions of the sample—as muscles have a fairly standard composition.

The data support the idea that raising birds on pasture results in leaner animals (more protein and less fat), as they have to forage more to get feed. The differences between farms are interesting, but the true degree of difference and the cause cannot be determined from the data. It is possible that age of the animal or the diet fed played a role.



Above: *Barney Bahrenfuse holds a plucked bird.*
Below: a bird comes out of the tub plucker.

Table 1

Nutrient Composition of Chickens reported by piece, farm type and whether cooked or uncooked

		Protein	Ash	Fat
	Breast	87.04	9.31	6.45
	Thigh	58.01	9.20	35.47
Overall	Conventional	65.67	9.36	30.34
Overall	Pasture	73.76	9.24	19.28
Overall	Cooked	74.20	9.37	18.54
Overall	Uncooked	70.85	9.14	23.38
Overall	Average	72.53	9.26	20.96
	Differences	*1,2,3,4*	*None*	*2,3,4*

1: Values differed between individual farms
2: Values differed between cooked and uncooked pieces
3: Values differed between breasts and thighs
4: Cooking affected nutrient content of breasts differently than it affected thighs

Micronutrients: Minerals

Minerals are an important component in animal and human diets: minerals like calcium and phosphorus are essential to bone structure, calcium and sodium and potassium are involved in cell structure and muscle contraction, and many others are needed to make enzymes that help with digestion and other body functions. Any adequate diet will ensure at least a basic level of nutrients, but there is some question as to whether the more natural and less processed feeds consumed on pasture might be more bioavailable and increase mineral content of chicken meat.

Mineral composition, shown in **Table 2,** did not differ between cooked and uncooked samples, with the exception of calcium (Ca; $P = 0.0538$). Cooking does not typically affect mineral content of foods, unless a significant amount of liquid is lost, which may account for some of the loss of calcium. Chicken from different farms had differing levels of Ca, K, Mg, P, S, and Zn ($P < 0.05$); this may be due to diet differences, but more thorough testing of feed rations and more meat samples would be required to ascertain the cause. Breasts and thighs differed in content of Fe, K, Mg, Na, P, S, and Zn ($P < 0.05$). Zapata and colleagues (1998) reported finding more Ca, Na, Fe, and Zn in dark meat than in light meat; the reverse was true for P, Mg, and K. Findings in the current study concur with those results.

Fatty Acids

Thighs were chosen to analyze for fatty acids because of the higher fat content compared to breasts. While differences between management styles could not be proven, there were some differences between cooked and uncooked thighs ($P < 0.01$) for content of linoleic, linolenic, and eicosapentaenoic acid (EPA). In addition, DHA (docosahexaenoic acid) content was different between farms ($P < 0.01$). Data for selected fatty acids of interest are shown in **Table 3.**

While traditionally regarded as unhealthy, fats are essential sources of energy and provide components of cell membranes and nervous tissue that cannot be obtained elsewhere. Different sources of fats (for instance, animal versus vegetable) have different ratios of omega-6 and omega-3 fatty acids, which are essential fatty acids of particular interest. Ideally, the omega-6 to omega-3 ratio should be 4:1 or lower (Simopoulos, 2002). Diets typical in the US have an exceedingly high omega ratio—estimated to be anywhere from 11:1 to 30:1 (Simopoulos, 2002; Daley et al., 2010)—and efforts are being taken to reduce this through changes in human and food animal dietary patterns. Pasture and forage do not contain much oil or fat, but that which they do have contains more omega-3s than are found in grain oils (Daley et al., 2010), which can be transferred into the body fat of monogastric animals (Mirghelenj et al., 2009).

Table 2

Mineral Composition of Chickens reported by piece,farm type and whether cooked or uncooked

		Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
	Breast	461	1.3	9.7	10288	852	0.14	1985	6791	6996	27.3
	Thigh	540	1.7	22.0	7342	541	0.10	1857	4389	5436	48.4
Overall	Conventional	461	1.1	14.9	8664	762	0.08	1788	5825	6197	30.7
	Pasture	511	1.6	16.4	8714	672	0.12	1938	5447	6152	40.0
	Cooked	448	1.7	17.9	8357	636	0.08	1882	5119	5935	42.1
	Uncooked	551	1.3	14.7	9009	728	0.14	1945	5833	6352	35.6
	Average	503	1.5	16.2	8707	685	0.12	1916	5502	6159	38.6
	Differences	*1,2*	*None*	*3*	*1,3*	*1,3*	*4*	*3*	*1,3*	*1,3*	*1,3*

1: Values differed between individual farms
2: Values differed between cooked and uncooked pieces
3: Values differed between breasts and thighs
4: Cooking affected nutrient content of breasts differently than it affected thighs

Table 3

Nutrient Composition of Chickens reported by piece, farm type and whether cooked or uncooked

	Linoleic (18:2 ω6)	Linolenic (18:3 ω3)	(20:5 ω3; EPA)	(22:6 ω3; DHA)
Conventional	9.88	0.35	0.00	0.12
Pasture	14.21	1.20	0.01	0.20
Cooked	19.72	1.89	0.01	0.12
Uncooked	8.53	0.42	0.00	0.24
Average	13.62	1.09	0.01	0.19
Differences	*2*	*2*	*None*	*1,2*

1: Values differed between individual farms
2: Values differed between cooked and uncooked pieces

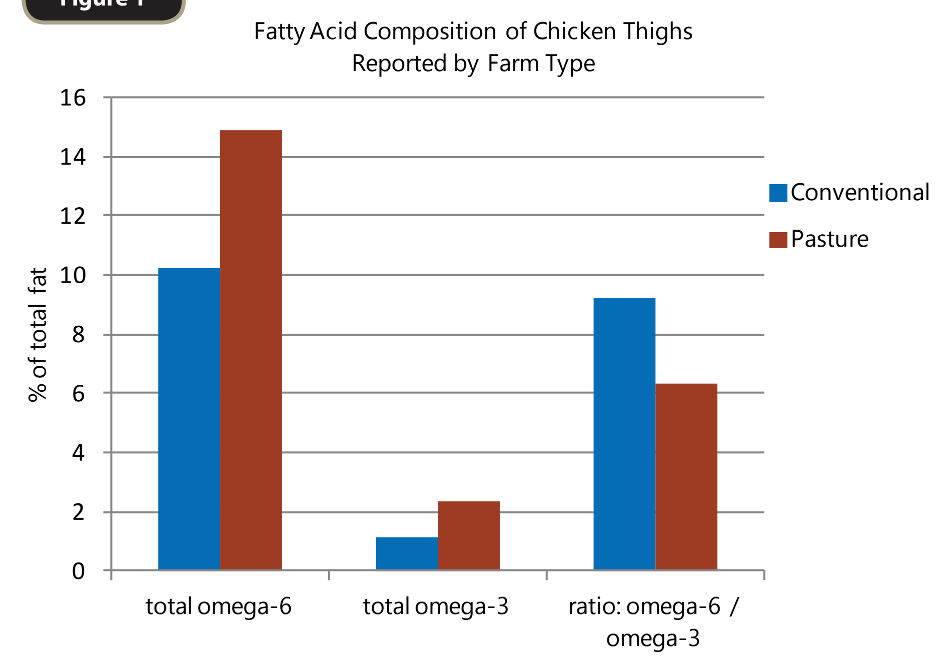
Again, limited data did not provide the power to identify statistically-significant differences between the conventional and pasture-raised birds. However, there is certainly a tendency for greater levels of both omega-6 and omega-3 fatty acids in the pasture-raised birds, shown in **Figure 1.** Both types of fatty acids are greater in pasture-raised birds, but the relative levels of omega-3s are such that there is a lower ratio compared to conventional birds. While more thorough sampling is needed, this data supports the theory that managing birds on grass increases the proportion of healthy fatty acids in their fat.

The omega-6 to omega-3 ratio has been suggested to have a role in the development of cardiovascular disease, cancer, and inflammatory and autoimmune diseases. Decreasing the ratio—either by increasing the amount of omega-3 fatty acids or decreasing the amount of omega-6 fatty acids—has been documented to reduce proliferation in some forms of cancer, and to reduce the risk of some other forms of cancer (Simopoulos, 2002). While the pastured birds' average ratio of about 6.3:1 is still above the target of less than 4:1, it is a vast improvement over the conventional average of about 9:1.

Conclusion

While the differences between nutrient content of pastured and conventionally-raised chickens could not be statistically confirmed here, data demonstrates that variation exists between chickens raised on different farms. As expected, breast meat was leaner (more protein and less fat) than thigh meat; cooked pieces also had more protein and less fat than uncooked pieces. Cooking did not affect mineral content of meat, but breasts and thighs differed in their content of iron, potassium, magnesium, sodium, phosphorus, sulfur, and zinc. Individual farms differed in protein content, some mineral content, and the DHA fatty acid content. Numerically, pastured chickens displayed a lower omega-6:omega-3 ratio, which has positive health implications for consumers.

Figure 1



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