Organic poultry production in the United States: Broilers[1]

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Primary Audience: Flock Supervisors, Quality Assurance Personnel, Researchers

SUMMARY

Since the USDA implemented the National Organic Program, the growth of the organic food market has continued to increase, with organic poultry as leading products. Organic livestock husbandry practices focus on living conditions that permit natural behaviors and provide outdoor access, preventive health management with a prohibition of antibiotics or other drugs (although vaccines can be used), and organic feed. Organic feed is raised without synthetic fertilizers and pesticides; pastures to which birds have access must also be organic. Hatcheries are currently not required to be organic, and conventional chicks may be used if they are under organic management by the second day after hatching. Although alternative, slow-growing genotypes are used in organic production in the European Union, conventional genetics are used in the United States. Poultry products, including meat and eggs, must be handled organically. Most synthetic materials are not permitted in organic food production, whereas most natural materials are; however, the National Organic Program National List specifies which materials are allowed. Of particular interest is an impending ban on the use of synthetic methionine in organic poultry diets. Research in the United States has examined alternative strategies, including the use of slow-growing broilers that are less heavily muscled than conventional fast-growing meat birds, but has not shown these birds to have lower methionine requirements. Research has also examined sensory differences between specialty and conventional meat chickens in the United States. Consumer panelists indicated no preference between these products, although trained panelists found some differences in the flavor of thigh meat. More meat quality differences were due to genotype than to outdoor access. Breast meat from slow-growing birds was more tender than that from fast-growing birds. Outdoor access resulted in leaner meat, but only in the case of slow-growing birds. As interest grows in specialty and organic poultry meat products, additional research is needed.

Key words: poultry, organic, National Organic Program, methionine, slow growing

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INTRODUCTION

Since the USDA established the National Organic Program (**NOP**) [1] in 2002, the organic food market has experienced strong growth, as much as 20% annually [2]. The organic meat category is relatively young but has been the fastest growing organic category since 2005, with organic broilers leading the way. The USDA maintains economic data on organic poultry production, including production by state. In 2005, the highest organic poultry-producing states were California, Pennsylvania, and Nebraska [3]. The USDA also records organic poultry prices [4].

"Organic" refers to the way livestock and agricultural products are raised and processed, which involves avoiding agrichemicals such as synthetic pesticides and fertilizers. Although "nonchemical" farming is a good working definition, avoiding agrichemicals is just one feature. According to Sundrum [5], organic poultry production focuses on animal health and welfare, good environmental practices, and product quality and focuses less on economic measures, such as reducing costs and maximizing production (BW gain, FE, etc.).

Organic poultry production in the United States has been described in terms of living conditions, health, origin of the birds, feed, and processing and allowed materials [6]. The NOP livestock standards are "descriptive" and do not contain many details for how organic poultry should be raised. Many details and numbers provided in this paper are not specified by the NOP, but rather are common interpretations by certifying agencies accredited by the NOP [6].

LIVING CONDITIONS

Housing should protect birds from the elements, maintain a comfortable temperature, provide ventilation and clean bedding, and allow birds to exercise and conduct natural behaviors. Cages are not permitted. In addition, the birds must have access to the outdoors for exercise areas, fresh air, and sunlight and must be able to scratch and dust bathe.

The NOP does not specify indoor or outdoor stocking densities, but certifying agencies look for a low stocking density, at least 0.14 m^2 per bird. There is no limit on the number of birds that can be raised in a flock under the NOP; in contrast, European Union organic regulations limit the size of flocks.

Most organic poultry production in the United States is raised under intensive, large-scale conditions similar to those in the conventional industry. Although birds must have access to the outdoors, often little outdoor access is provided. Livestock and poultry may be temporarily confined for inclement weather, the stage of production, conditions under which the health, safety, or well-being of the animal could be jeopardized, or conditions that pose a risk to soil or water quality. Therefore, in many operations, the bird exits or "popholes" remain closed during winter months. There is no requirement about the number of popholes, and the outdoor area may be small and with little grassy vegetation. However, on small farms in the United States, small portable houses are generally used and moved regularly to fresh pasture; birds have ample outdoor access, although the housing is usually not sophisticated in terms of ventilation or automated feed or water equipment [6].

HEALTH

Proactive health management is important in organic poultry production. Producers must provide adequate housing and space, ventilation, and good nutrition to reduce stress and maintain the bird's immune system. The introduction of disease should be prevented with the use of vaccines and biosecurity practices.

Probiotics and prebiotics are often used in organic poultry production, particularly to replace antibiotic growth promoters, which are not permitted. These beneficial microbes establish beneficial gut microflora, reducing colonization by pathogenic organisms. The NOP emphasizes that no drugs, growth promotants, or synthetic parasiticides are permitted, although natural materials can be used. No materials in violation of the Federal Food, Drug, and Cosmetic Act should be used. Antibiotics and other medical treatments must not be withheld if they are needed, but birds treated with prohibited materials should be diverted to nonorganic markets.

Interestingly, mortality may be higher in large-scale organic production than in conventional production because medications are not

permitted. Necrotic enteritis is a common health problem in large organic broiler flocks.

Proper sanitation and good biosecurity should be followed on the organic farm. Approved materials that are used for disinfection and sanitation of the premises and equipment include chlorine materials, iodine, hydrogen peroxide, peracetic acid, phosphoric acid, and alcohol. Propane-fueled heat tools can also used to disinfect, and sunlight and dry conditions help reduce pathogens in outdoor areas. Good biosecurity is important in any poultry operation and particularly in organic operations. Because wild birds, particularly waterfowl, can carry diseases that harm domestic poultry, the outdoor area should be designed without ponds and other attractions for wild waterfowl. Outdoor feeders may need to be a dispensing design instead of open. Physical alterations to the bird are allowed if they are essential for animal welfare and provided in a manner that minimizes pain [6].

ORIGIN OF BIRDS AND GENETICS

The NOP does not require the origin of the birds to be organic. In fact, there are currently no commercial certified organic poultry hatcheries in the United States. Nonorganic chicks are used, but must be under organic management by the second day after hatch.

The NOP stipulates that breeds should be chosen for their resistance to disease and their appropriateness to a site or operation. However, in the United States, high-yielding genetics are typically used in both conventional and organic poultry production [6].

The conventional fast-growing (**Fast**) broiler is an efficient bird that grows to market BW in 7 wk and has a high yield of breast meat. However, it may have health issues caused by the fast growth, including metabolic problems such as ascites, sudden death syndrome, and leg problems such as lameness. In contrast, slow-growing (**Slow**) meat birds are used in the European Union organic program; these birds may take 12 wk to grow to market BW. Although Slow birds are less efficient meat producers, they have better livability, are more active, and may have differences in meat quality.

Research in the United States was conducted to determine the impact of genotype (Fast vs. Slow) and production system (indoor production vs. access to outdoors) on the performance and meat quality of birds for specialty markets [7–9]. The Slow and Fast genotypes were raised for 91 and 63 d, respectively, and only females were used. The Slow birds were placed before the Fast birds to achieve a similar BW at processing. Each genotype was assigned to 8 pens of 20 birds each, with 4 pens within each genotype raised indoors in a conventional research facility or in a small facility with outdoor access. All birds were fed a low-nutrient diet, which is common in the European Union with Slow birds. Birds were commercially processed and deboned at 4 h postmortem. Descriptive analysis of breast and thigh meat was conducted by a trained descriptive panel on all treatments. Consumer analysis was also conducted on the breast and thigh meat from only 2 treatments: Slow birds raised with outdoor access (Slow–outdoor) and Fast birds raised indoors (Fast–indoor).

The production system did not affect BW gain, but BW gain of the Fast genotype exceeded that of the Slow birds, even though the Slow birds were placed 4 wk before the Fast birds (Table 1). Overall feed intake was not affected by genotype. The production system with outdoor access increased feed intake of both genotypes, but had a greater impact on the feed intake of Slow birds. As expected, feed conversion of the Fast birds was better than that of the Slow birds. Feed conversion was worsened by outdoor access in both genotypes, and the effect was more pronounced in the Slow birds. Cold temperatures are known to increase feed intake and worsen feed conversion. Foraging activity and exercise could also conceivably increase feed intake and worsen feed conversion. Birds of the Slow genotype were much more active and appeared to forage more, whereas the Fast birds rarely went outside.

The Slow birds had much lower mortality than birds of the Fast genotype (Table 1). The Slow birds had better gait scores than the Fast birds, and in the Fast birds, outdoor access improved gait score, most likely resulting in better gait score because of the opportunity for exercise (gait data not shown).

Carcass weights reflected differences in BW gain, with the Fast birds having higher carcass weights than the Slow birds (Table 2). Similarly,

Table 1. Effect of genotype and production system on growth performance, bone health, and mortality[1]

Genotype[2]	Production system	BW gain,[3] g	Feed intake,[3] g	Feed:gain,[3] g/g	BMD,[4] g/cm^2	Mortality,[3] %
Slow-growing	Outdoor access	2,254[b]	8,459[a]	3.75[a]	0.193	3[b]
Slow-growing	Indoor	2,105[b]	6,752[c]	3.21[b]	0.189	0[b]
Fast-growing	Outdoor access	3,370[a]	8,087[a]	2.40[c]	0.183	11[a]
Fast-growing	Indoor	3,389[a]	7,402[b]	2.19[d]	0.185	9[a]
Pooled SEM		54	172	0.06	0.007	4
ANOVA				*P*-value		
Genotype		0.0010	0.4362	0.0001	0.5283	0.0364
Production system		0.2545	0.0001	0.0001	0.8164	0.5137
Genotype × production system		0.1451	0.0118	0.0151	0.5576	1.0000

[a–d]Means within a column lacking a common superscript differ significantly ($P < 0.05$).

[1]Adapted from Fanatico et al. [7].

[2]Slow- and fast-growing birds were grown for 91 or 63 d, respectively; placement dates were staggered such that there was a single trial termination date.

[3]Values are means of 4 pens of 20 female birds.

[4]Bone mineral density (BMD) values (adjusted for BW) represent the mean averaged across the tibia and humerus with 18 to 19 observations per mean.

ready-to-cook yield was higher for the Fast birds. There was no impact of outdoor access on breast weight and breast yield, but both were affected by genotype, with the Fast birds exhibiting far superior values in both categories. This reflects the fact that Fast birds have been selected for high breast yield. Wing yield was reduced and leg yield was increased by outdoor access; for both parameters, the impact of outdoor access was greater in the Slow birds. There was a significant genotype effect on wing, leg, and frame yield; Slow broilers had a higher percentage of yield in each category, which is reflective of the large percentage difference in breast yield.

There were no significant differences among treatments for DM or ash in breast meat, indicating little difference in mineral contents (Table 3). There was a genotype effect for protein content of the breast meat. The Slow birds had higher protein content than Fast birds (Table 3), which may be related to age. Typically, as an animal ages, the composition of body and muscle changes; protein and fat increase, whereas moisture decreases [10]. Production system also affected protein content. The outdoor birds had higher protein content than indoor birds (Table 3), possibly because the exercise in an outdoor system contributed to muscle development and thus higher protein content.

There were also genotype and production system effects in terms of intramuscular fat content. The breast meat of the Slow birds had half the amount of fat compared with Fast birds (Table 3). The outdoor birds had lower fat than the indoor birds (Table 3). This is consistent with other studies that have shown that the additional space provided in free-range and organic production increases leanness in poultry, most likely because of activity [11–13].

There was an interaction between genotype and production system for the b* value (yellowness) of the skin. The Slow birds had significantly higher b* values than Fast birds both indoors and outdoors, indicating more yellow skin, and when the Slow birds had access to the outdoors, their skin became even more yellow than when they were indoors (Table 4). Production system had no effect on skin color of the Fast birds. This interaction was attributed to the fact that the Slow birds spent more time outdoors and were more active and foraged more than the Fast birds. Apparently, the Fast birds did not forage sufficiently to ingest pigments from the plants. This interaction was also evident in the meat and was in agreement with previous findings [14].

Although all breast meat pH values were in normal ranges and did not indicate problems, the Slow birds had a lower ultimate pH com-

Table 2. Effect of genotype and production system on meat yield[1,2]

Genotype[3]	Production system	Carcass weight, kg	RTC yield,[4] %	Breast weight,[5] g	Breast yield,[6] %	Wing yield,[6] %	Leg yield,[6] %	Frame yield,[6,7] %
Slow-growing	Outdoor access	1.65[b]	71.5[c]	312[b]	18.9[b]	11.5[b]	32.9[a]	36.0[a]
Slow-growing	Indoor	1.57[b]	73.4[b]	296[b]	18.8[b]	12.3[a]	31.4[b]	36.1[a]
Fast-growing	Outdoor access	2.62[a]	76.4[a]	792[a]	30.1[a]	10.6[c]	29.7[c]	29.2[b]
Fast-growing	Indoor	2.63[a]	76.3[a]	800[a]	30.5[a]	10.8[bc]	29.1[c]	29.4[b]
Pooled SEM		0.01	0.04	26	0.4	0.1	0.3	0.3
ANOVA		*P*-value						
Genotype		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Production system		0.5789	0.0424	0.8776	0.7693	0.0005	0.0023	0.7279
Genotype × production system		0.4236	0.0307	0.6654	0.6068	0.0139	0.0948	0.9454

[a–c]Means within a column lacking a common superscript differ significantly ($P < 0.05$).

[1]Adapted from Fanatico et al. [7].

[2]Values are means of 4 pens of 20 female birds.

[3]Slow- and fast-growing birds were grown for 91 or 63 d, respectively; placement dates were staggered such that there was a single trial termination date.

[4]Ready-to-cook (RTC) yield represents the chilled carcass weight as a percentage of BW.

[5]Pectoralis major and pectoralis minor (boneless, skinless).

[6]Calculated as a percentage of chilled RTC weight.

[7]Frame is the carcass including the skin but with the breast, wings, and legs removed.

pared with the Fast birds (Table 3). Functional qualities were not superior in the breast meat of Slow birds, and in fact, their meat had poorer water-holding capacity compared with the meat of the Fast birds.

Texture, particularly tenderness, is a crucial consumer attribute. The Slow birds were more tender than the Fast birds as measured by the Meullenet-Owens razor shear method (lower total energy; Table 3) [15]. The values for Slow treatments were in the category of "extremely tender" and the Fast treatments were categorized as "moderately to slightly tender." It had been expected that the Slow birds would be less tender than the Fast birds because the Slow birds were older. According to Fletcher [16], older birds are more mature at the time of harvest and have more cross-linking of collagen. Although

Table 3. Impact of genotype and production system on meat quality characteristics in breast meat[1]

Item	DM,[2] %	Ash,[2] %	Protein,[2] %	Fat,[2,3] %	pH[2]	TE,[4] N·mm
Slow–outdoor access	26.37	4.00	13.90[a]	4.47[b]	5.53[c]	111.16[b]
Slow–indoor	25.99	4.10	13.56[b]	5.25[b]	5.60[b]	102.57[b]
Fast–outdoor access	25.56	4.10	13.45[b]	7.90[a]	5.72[a]	140.11[a]
Fast–indoor	26.5	4.00	13.00[c]	8.86[a]	5.69[a]	149.88[a]
Pooled SEM	0.26	0.05	0.09	0.33	0.02	5.10
ANOVA	*P*-value					
Genotype	0.2280	0.9132	0.0001	0.0001	0.0001	0.0001
Production system	0.6818	0.5980	0.0010	0.0214	0.2947	0.9096
Genotype × production system	0.0799	0.1470	0.5465	0.7812	0.0187	0.0941

[a–c]Means within a column lacking a common superscript differ significantly ($P < 0.05$).

[1]Adapted from Fanatico et al. [8]. Slow = slow-growing genotype; Fast = fast-growing genotype.

[2]n = 20.

[3]Based on a percentage of DM.

[4]Meullenet-Owens razor shear [15]. TE = total energy (n = 40).

Table 4. Impact of genotype and production system on breast meat and thigh skin color[1,2]

Item	Skin			Meat		
	L*	a*	b*	L*	a*	b*
Slow–outdoor access	72.19[b]	0.44[c]	14.58[a]	51.04[a]	2.55[b]	7.55[a]
Slow–indoor	73.68[a]	−0.17[d]	13.17[b]	51.91[b]	2.54[b]	6.32[b]
Fast–outdoor access	69.86[c]	4.01[a]	9.98[c]	51.77[ab]	4.12[a]	4.84[c]
Fast–indoor	70.05[c]	3.32[b]	10.27[c]	52.16[b]	3.83[a]	5.29[c]
Pooled SEM	0.49	0.27	0.39	0.25	0.18	0.20
ANOVA	*P*-value					
Genotype	0.0001	0.0001	0.0001	0.0750	0.0001	0.0001
Production system	0.0049	0.0004	0.1768	0.0289	0.4244	0.0765
Genotype × production system	0.0211	0.7523	0.0489	0.3552	0.4618	0.0013

[a–d]Means within a column lacking a common superscript differ significantly ($P < 0.05$).

[1]Adapted from Fanatico et al. [8]. Higher L*, a*, b* values indicate lightness, redness, and yellowness, respectively. Slow = slow-growing genotype; Fast = fast-growing genotype.

[2]n = 80; measured at 24 h postmortem.

all treatments were deboned at 4 h postmortem, it is possible that the Fast and Slow genotypes had different rates of rigor because of their different BW.

In terms of sensory analysis, the descriptive panel found a trend for breast meat from the outdoor birds to be more cohesive than that of the indoor birds in the first-bite stage (descriptive panel data not shown). This is in agreement with other research showing that outdoor access resulted in meat that was more firm than meat from indoor production [12, 17]. However, according to Dingboom and Weijs [18], the impact of exercise on meat quality is minor and ambiguous.

The untrained consumer panel found no significant differences in the texture of the breast meat or thigh meat of Slow–outdoor (specialty) or Fast–indoor (conventional) birds (Table 5). Because consumers are not trained as a descriptive panel to detect subtle differences in texture, it is not surprising that the consumer panel found no differences in texture.

There were more differences in flavor among treatments in dark meat than in breast meat (data not shown), which is not surprising because the

Table 5. Comparison of sensory attributes of specialty and conventional poultry products (consumer panel)[1,2]

Item	Specialty, Slow–outdoor access	Conventional, Fast–Indoor	RMSE[3]	*P*-value[4]
Breast				
Overall	6.68	6.67	1.6737	0.9622
Appearance	7.05	7.30	1.1179	0.1586
Texture	6.52	6.68	1.7484	0.5559
Flavor	6.48	6.73	1.4956	0.2907
Thigh				
Overall	6.05	6.41	1.6292	0.1755
Appearance	5.67	5.95	1.79	0.3312
Texture	6.22	6.60	1.72	0.1832
Flavor	6.22	6.32	1.50	0.6726

[1]Adapted from Fanatico et al. [9]. Slow = slow-growing genotype; Fast = fast-growing genotype.

[2]9-point hedonic scales were used to assess overall liking and liking of appearance, texture, and of flavor (1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely).

[3]Root mean square error.

[4]*P*-values for no difference in mean score.

dark meat has more fat, and flavor is positively correlated with lipid level [19].

Meat flavor increases with age, likely because of the increased concentration of nucleotides in muscle [10]. According to Farmer [20], age has a consistent effect on flavor, whereas genotype, sex, BW, and production system have more varying effects. The conventional bird is generally young, very tender, and juicy but has a less intense flavor [21].

Although the descriptive panel detected some flavor differences among products, the consumer panel did not indicate differences in liking of flavor between specialty and conventional poultry products (Table 5). Specialty poultry products are reported to have more flavor and to be more firm than conventional products in some literature from the European Union [12, 22, 23]. This series of studies concluded that consumers must be willing to pay a premium for alterative poultry products to overcome inefficiencies in the production system and to offset the higher cost of production associated with Slow genotypes.

FEED

The feed must be organic, including pasture and forage, and is usually expensive compared with conventional feed. Because feeds that have been defatted with chemical solvents are not permitted, only roasted, extruded, or expelled soybeans are used. Animal drugs, slaughter byproducts, antibiotics, and feed from genetically modified organisms (**GMO**) are not allowed in organic feed.

Feed may also contain natural, nonagricultural feed additives and supplements or there may be approved synthetic substances that are allowed by the NOP National List, which basically allows minerals and vitamins. Feed additives and supplements must comply with the Federal Food, Drug, and Cosmetic Act.

Although synthetic vitamins or minerals are permitted in organic production, synthetic amino acids are not; however, synthetic methionine is permitted for a limited time for poultry. Feed supplements, such as fishmeal, enzymes, and oyster shell, are permitted in larger amounts than feed additives to improve the nutrient balance. The fishmeal does not have to be organic, because it is a natural substance used as a feed supplement. However, prohibited substances such as ethoxyquin cannot be added to preserve the fishmeal. Feed additives or supplements cannot be from GMO.

Methionine is the only synthetic amino acid permitted in organic livestock production and is permitted for poultry only until October 2010 under the NOP. The upcoming ban is problematic because synthetic methionine is currently added to virtually all commercial poultry diets. There is interest in supplying methionine as an intact protein. High-methionine corn is being developed [24], but crop yields may be lower, which could reduce interest on the part of farmers in growing the crop, even with a premium price [25]. Fishmeal is naturally high in methionine; however, the supply without prohibited preservatives is limited. In addition, some companies market their poultry products as not having been fed animal products and therefore do not use fishmeal.

Supplying sufficient methionine to birds with plant proteins, such as soybeans or sunflower meal, may result in diets with protein levels that are too high, and feeding excessive levels of protein can be harmful to both the bird and the environment [26]. Birds excrete the nitrogen in protein as uric acid, which is broken down into water and ammonia. Because excess protein causes watery droppings, the moisture content of the litter can increase. High-moisture litter creates an optimal environment for pathogens and can cause breast blisters. Excess ammonia can also cause respiratory problems, which increases the susceptibility of birds to other diseases, and ammonia emissions from the poultry house are a concern for air quality. Metabolizing excess protein can also be detrimental to the bird, stressing the kidneys, depending on the extent of the excess. Conventional poultry producers use synthetic amino acids to reduce nitrogen excretion, but organic poultry producers will not have this tool in the future [26].

Corn gluten meal is high in methionine, but there is none in organic form. Increasingly, innovative protein sources such as algae, earthworm, or insect meal are of interest [27].

Some literature suggests that birds of Slow genotypes that are lower yielding may have lower methionine requirements [5]. However, in US

research, 6 trials were conducted to determine the methionine and sulfur amino acid (**SAA**) requirements of alternative genotypes during the starter (7 to 21 d), grower (28 to 42 d), and finisher (49 to 63 d) phases [28]. In each trial, 5 graded levels of DL-methionine were added to corn-peanut meal basal diets that were deficient in methionine (methionine requirement trials) or deficient in methionine and cysteine (SAA requirement trials). Experimental diets were fed to 3 genotypes: Slow, medium-growing (**Medium**), and Fast (starter and grower phase only). Each dietary treatment was fed to 5 replicate pens containing 5 male chicks (starter period) or 13 male chicks (grower and finisher phases). In the final trial (experiment 6), the Slow genotype was not available from the breeding company and only Medium birds were evaluated. Growth data were fitted to a broken line (when appropriate) such that an objective inflection point could be established.

For each genotype (with the exception of the Slow birds in experiment 4), BW gain and FE improved with addition of DL-methionine in experiments 1, 2, 3, and 4. Broken-line analysis with BW gain regressed against digestible methionine or SAA intake revealed methionine requirements (for the Slow, Medium, and Fast genotypes, respectively) of 0.33, 0.30, and 0.33% for the starter phase and 0.28, 0.29, and 0.28% for the grower phase. In the finisher phase, the estimated methionine requirement for the Slow genotype was 0.25%; no BW gain or FE response occurred in the Medium genotype in response to DL-methionine addition, indicating that the basal diet contained adequate methionine (0.22%). For the starter and grower periods, estimates of SAA requirements ranged from 0.57 to 0.60%, regardless of genotype; extreme variability prevented the estimation of SAA requirements during the finisher phase. Broken-line analysis with BW gain regressed against digestible methionine or SAA intake revealed similar methionine and SAA requirements among the genotypes during the starter and grower phases.

An additional trial examined methionine requirements of alternative genotypes throughout the entire growing period and examined the use of feed formulations using only intact protein sources of methionine (no synthetic methionine) [29]. Three genotypes with different growth rates (Slow, Medium, and Fast) were given a low-methionine basal diet or diets containing intermediate or high methionine levels that were formulated with or without synthetic DL-methionine; thus, 5 experimental diets were fed to each genotype. The methionine requirements for Slow birds were determined in previous research [28]. Low-, intermediate-, and high-methionine diets were formulated to contain 80, 100, and 120% of the requirement, respectively. Digestible methionine levels (for the low-, intermediate-, and high-methionine diets) were 0.30, 0.36, and 0.42% in the starter phase, 0.26, 0.30, and 0.34% in the grower phase, and 0.22, 0.26, and 0.30% in the finisher phase. Twenty male birds were randomly assigned to pens, with 5 replicate pens per treatment. Slow, Medium, and Fast birds were raised to 77, 63, and 49 d of age, respectively, and placement of the different genotypes was staggered to process all birds on the same day. The birds did not have outdoor access and, being part of a series of studies, were not raised under strict organic requirements in this particular study. Birds were commercially processed and deboned at 4.5 h postmortem. Carcass and parts yield were calculated from 5 birds from each replicate.

Genotype had a significant impact on BW gain, feed intake, FE, and yield. The Fast birds had greater BW gain, improved FE, and greater carcass and parts yield than Slow birds. Higher levels of dietary methionine increased BW gain (Figure 1). The breast yield of all genotypes was affected by methionine level, with higher breast yields from treatments with higher levels of methionine (Figure 2). The Slow genotype had lower breast yields than the Fast genotype but had higher wing and leg yields (wing and leg data not shown). Diet formulations without DL-methionine (using intact-protein diets with higher CP levels) did not compromise growth or yield. These data exhibited the impact of genotype and methionine level on the performance of birds for organic markets and demonstrated the use of intact-protein sources as an alternative to synthetic DL-methionine. Slow genotypes have less efficient performance and do not appear to have substantially lower methionine requirements, which agrees with previous research [28]. Intact

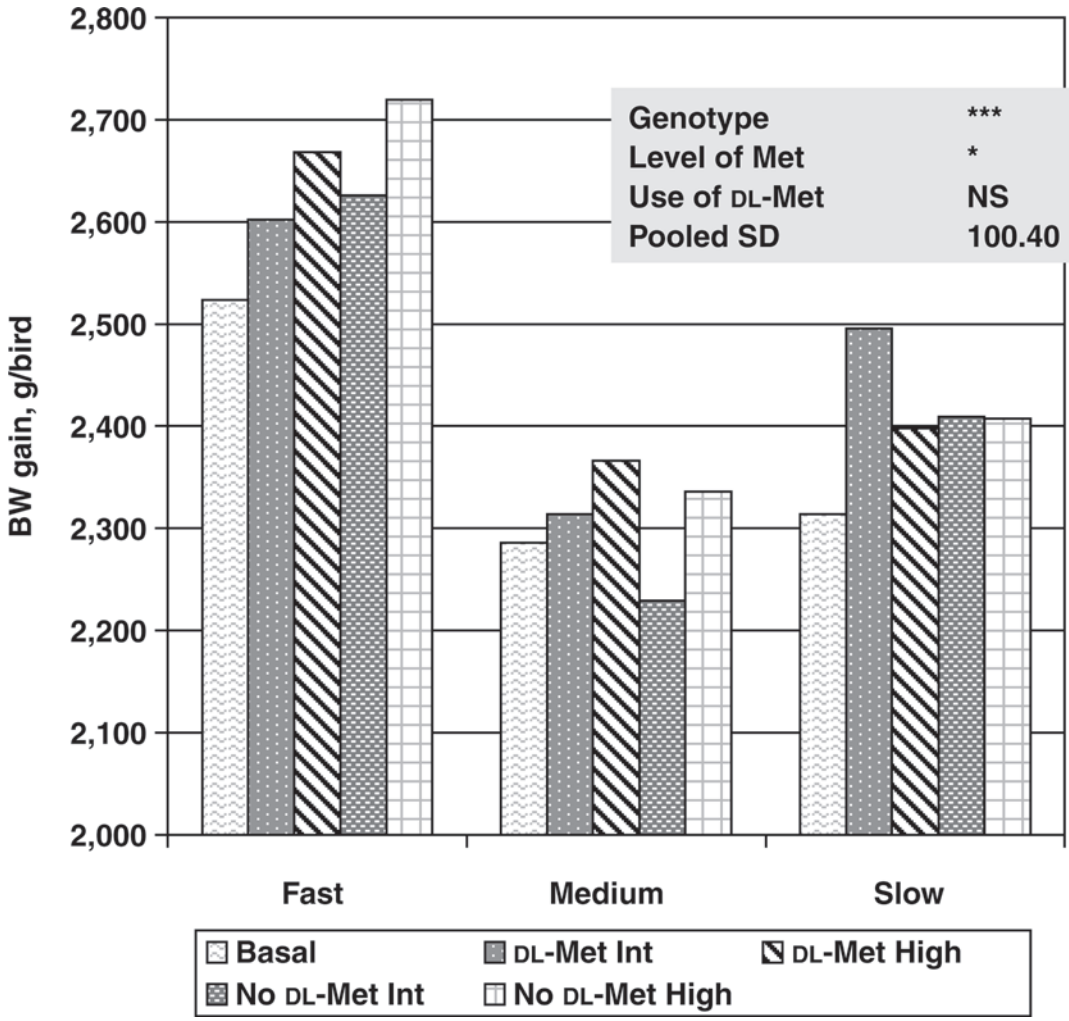

Figure 1. Total BW gain of 3 genotypes fed diets with basal, intermediate (Int), or high levels of methionine with or without the use of DL-methionine. *$P < 0.05$; ***$P < 0.001$; NS = not significant; $P > 0.05$.

proteins can be used in specialty diets in place of methionine, although the protein content of the diet may be higher. Costs will be higher for intact-protein diets. Costs of organic ingredients are higher than in conventional diets, and sourcing may be an issue.

Moritz [30], conducting research on a university organic sheep and poultry farm with small portable houses and ample pasture, determined that synthetic methionine is not needed for growing organic broiler chickens to achieve market BW or to prevent unacceptable levels of morbidity and mortality (synthetic methionine was used in the starter phase). He also found that Fast genotypes outperformed Slow genotypes.

PROCESSING

If meat or eggs are processed on farm, the processing must comply with the NOP organic handling standards; if the meat or eggs are handled off farm, the processing plant must be certified organic.

Processing plants that are that already complying with federal or state regulations are usually not difficult to certify as organic. Important points include using approved organic detergents and sanitizers and pest control methods, preventing contamination, and preventing commingling with nonorganic products.

Sanitizers that may be used in organic poultry meat processing facilities to sanitize facilities

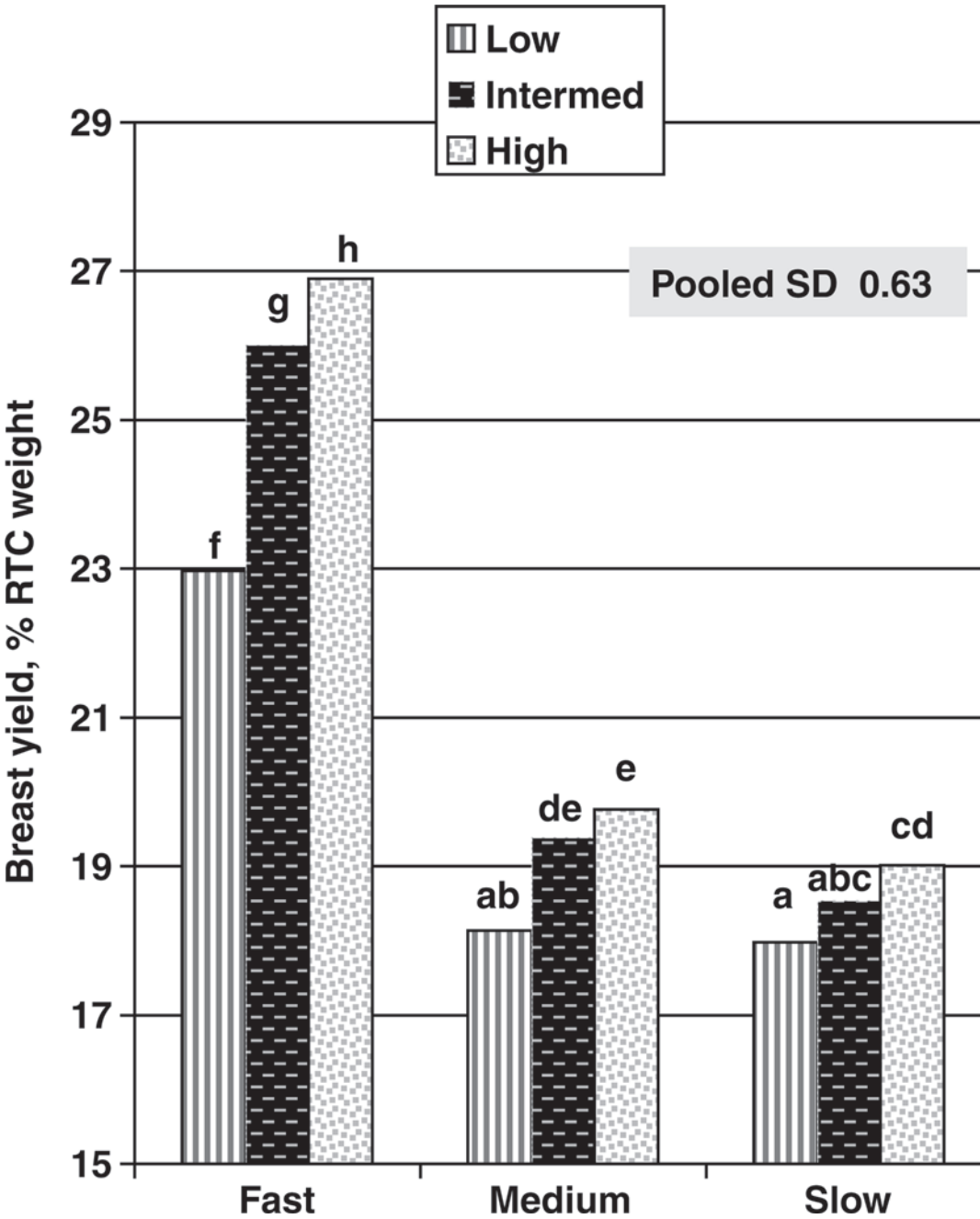

Figure 2. Breast yield interaction of level of methionine and genotype. RTC = ready-to-cook. [a–h]Bars without a common letter differ significantly ($P < 0.05$). Intermed = intermediate.

and equipment are more limited than in conventional facilities and include chlorine materials, hydrogen peroxide, peracetic acid, and phosphoric acid. Certifying agencies may allow prohibited materials to be used if a thorough rinse or sufficient time period removes the residue.

Additional requirements include an organic system plan, which is a description of contamination prevention practices, monitoring practices, and lists of inputs. Record keeping is an important process in the organic audit trail to document that the standards have been followed.

Flocks must be identified and receipts kept for stock and materials purchases, all health treatments and other inputs, purchased feeds, BW of slaughter animals, slaughter, packing and handling, sales records, and more. Records should be kept for at least 5 yr. Split production is permitted, but commingling must be prevented. No excluded methods, such as GMO and ionizing radiation, are permitted [6].

Additional resources on organic poultry may be obtained from www.attra.ncat.org. For information on producing organic poultry under the European Union regulations, see Thear [31] and the European Union Council Regulation [32].

CONCLUSIONS AND APPLICATIONS

1. Organic poultry are raised according to the USDA NOP livestock requirements.
2. The alternative slow-growing genetics are less efficient than fast-growing genetics in terms of yield, but have better livability.
3. Meat quality differences are more often due to genotype and age than to the production system.
4. The slow-growing birds do not have lower methionine requirements than the Fast birds; the use of synthetic methionine is a key issue for organic broiler producers because there is an upcoming ban by the NOP.

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