Assessment of a global positioning system to evaluate activities of organic chickens at pasture

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Primary Audience: Organic Broiler Production Managers, Researchers, Geneticists, Production, Well-Being Auditors

SUMMARY

The aims of the present study were to assess the use of a global positioning system (GPS) monitoring device to evaluate the activities of organic chickens at pasture. Two hundred male birds from 2 strains (100 slow-growing and 100 fast-growing birds) were reared separately in 4 indoor pens (0.10 m^2/bird), each with access to a grass paddock (10 m^2/bird; 2 replications/genotype). During the last week of age (from 73 to 80 d of age), the kinetic activity of chickens was monitored by behavioral observations (n = 20; focal bird sampling method) and a GPS (n = 10; Super Trackstick, Atex International, Route d'Esch, Luxembourg) equipped with a universal serial bus port for quick viewing on Google Earth's 3-D model, giving information concerning the date, hour, environmental conditions, and coordinates of monitored birds. Based on the focal bird sampling method, fast-growing birds tended to stay indoors rather than forage in the pasture, whereas slow-growing birds spent more time outdoors ($P < 0.05$). Moreover, visual observations confirmed GPS records, whereas slow-growing birds were observed to perform more active behaviors, stand less, and spend more time outdoors than indoors. Based on GPS tracks, slow-growing chickens covered an average daily distance of 1,230 m, whereas fast-growing birds covered only 125 m. In conclusion, GPS appears to be a suitable way to evaluate the kinetic activity of chickens. We also concluded that locomotor activity, which requires a high energy consumption, is low in fast-growing birds compared with slow-growing ones, allowing the fast-growing birds to reallocate energy to productive traits.

Key words: organic poultry system, chicken, global positioning system

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DESCRIPTION OF PROBLEM

In recent years, the "natural" status is becoming an increasingly important consumer demand. This has resulted in the development of different production methods, such as organic systems, capable of satisfying consumer requests regarding product quality while also taking into consideration animal welfare and environmental protection in the whole production chain.

In Europe, organic rearing of poultry is legislated by European Union Regulation 834/07 [1], which provides specifications for housing conditions, feeding, breeding and poultry care, dis-

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ease prevention, and veterinary treatment. Some of these rules are compulsory (feed, veterinary treatment, space allowance, age at slaughter), whereas others are only recommendations (grass availability and genetic strain). Unfortunately, the recommendations are usually not respected, and those regarding the genotype have major effects on poultry welfare and health [2], as well as on the nutritional quality of meat [3–5].

In a previous study [6], we found that fast-growing chickens had a high growth rate and feed conversion index, reaching a high BW at the minimum age at slaughter required by organic rules (81 d), but the mortality and the culling rate were high, indicating that these strains do not adapt well to organic production. Indeed, not all genotypes are suitable for organic rearing conditions: modern meat-type birds, strongly selected for high yield and fast growth rates, tend to be inactive and do not benefit from large space allowances [6–8]. Moreover, in the poultry industry, footpad dermatitis (**FPD**) is relevant to poultry welfare concerns; broilers with severe FPD exhibit a pain-induced lack of appetite [9]. Indeed, Schmidt and Lüders [10], who studied turkey poults, suggested that the lesions cause pain, resulting in a reluctance to move. Moreover, flocks with a high incidence of FPD often also show a high prevalence of other types of contact dermatitis, such as breast blisters and hock burns [9, 11]. Such fast-growing chickens are less active than lighter hybrids, especially as their age increases [11, 12]. On the contrary, slow-growing strains show good foraging and kinetic behavior and an appropriate use of pasture [13]. The behavior of poultry is an important research topic because it is fundamental to characterizing the interactions between birds and their environment [14]. Although visual observation is still the most common means of behavior assessment [15], various devices for automatic recording of grazing behavior in general and of specific aspects, such as head or body position, walking speed, and bird location, have been developed during the past 20 yr [16, 17]. Since the mid-1990s, the use of global positioning system (**GPS**) technology has rapidly advanced to a standard method: GPS units molded into neck collars have been used in studies on habitat use and tracking routes of wild and domestic animals [14, 18–20]. Livestock in extensive systems can graze across large areas, and there is limited opportunity to observe these animals frequently. In this context, the GPS method could be useful for examining, measuring, and regularly monitoring the welfare of livestock. The ability to inspect birds individually and monitor changes at the behavioral level may help livestock owners to detect health and welfare problems.

The GPS technology derives coordinates of latitude, longitude, and elevation from the triangulation of radio signals transmitted by a system of 24 geo-orbiting satellites. Detailed descriptions of the concept of GPS technology have been given by several authors [21–25].

Because there is a lack of information in the literature on applying this technology to poultry, the first aim of the present study was to assess the usefulness of a GPS monitoring system for evaluating the kinetic activity of organic chickens. The second aim of the present study was to evaluate appropriate genetics for organic poultry production.

MATERIALS AND METHODS

Birds and Farming System

Two hundred male chicks, 100 from slow-growing and 100 from fast-growing strains, were kept separately from hatch to 20 d of age in an environmentally controlled poultry house with temperature and RH ranging from 32 to 20°C and from 70 to 65% RH, respectively. At 21 d of age, they were transferred to 4 straw-bedded indoor pens (0.10 m^2/bird), each equipped with feeders and drinkers and with free access to a grass paddock (10 m^2/bird; 2 replications/genotype). Ancona crossbred birds [26, 27] were used as the slow-growing strain, and Ross 308 birds [28] were used as the fast-growing strain. All birds were reared according to European Union Regulation 834/07 [1] and Italian directives [29] on poultry welfare for experimental and other scientific purposes.

The pasture lands were not treated with pesticides or herbicides in the 3 yr prior to organic production. The pasture area also had mature trees, bushes, and hedges. The chicks were vaccinated at hatch against Marek's disease and Newcastle disease. Chicks were fed starter (1 to 21 d) and finisher (22 d to slaughter, 81 d) diets that, as required by the European Union Regulation [1], contained 100% organic ingredients, certified by a national agency. Whereas typical meat-type diets begin at 22% CP and finish at 17 to 18% CP, organic rations begin at approximately 20 to 21% CP and finish at 15 to 16% CP. Such a low protein ration is also used to slow the rapid growth of meat-type broilers, which are the types used in the current study. Feed and water were provided ad libitum. Individual BW were recorded every week (50 birds/strain), and mean daily BW gain and FE were calculated accordingly. Bird mortality and BW were recorded daily. Chickens from both groups were slaughtered at 81 d of age.

Behavioral Observations

The kinetic activity of chickens was monitored from 73 to 80 d by the following methods:

1. Behavioral observations. Behavioral observations were recorded during the last week of age (from 73 until 80 d) in the morning and afternoon, for 2 periods of 3 h each, using the focal bird sampling method [30]. Before each observation, 5 min was allowed for the birds to adapt to the presence of the observer. Twenty birds per strain were chosen at random and marked with different colors on the tip of the tail. The behavioral observations included moving (running, walking, foraging), lying, standing, eating (food and water), ground pecking, wing flapping, and others (birds preening and pecking self or other birds). A purposefully designed table was used to record the location of the focal bird (indoors or outdoors) and its behavior. The respective frequencies were calculated as a percentage of time spent indoors or outdoors and of the total observed behaviors. Because no differences were found between days and hours, all data were pooled to obtain a mean value.

2. GPS monitoring. Ten birds per genotype were monitored by GPS for 3 d using a Super Trackstick system [31] equipped with a universal serial bus port for quick viewing on Google Earth's 3-D model, where it is possible to read the date, hour, environmental conditions, and coordinates of monitored birds (http://www.trackstick.com). The apparatus, which weighs approximately 50 g, was attached to the outer part of the body by a belt Velcro system. Only the tracks obtained on the second and third days were used, to reduce data related to anomalous behavior attributable to the application of the apparatus. The variables recorded were overall distance (m), maximum distance from the bird house (m), time spent outdoors (%), and mean speed (m/h).

FPD, Qualitative Traits of Carcass Evaluations, and Statistical Analyses

At slaughter, the FPD of all birds in each group was assessed by assigning them to 1 of 3 different classes: 0 = no mark (no lesion), 1 = mild lesions (superficial lesions, erosions, papillae, and discoloration of the footpad), or 2 = severe lesions (deep lesions, ulcers, and scabs) [32]. The FPD score was obtained by applying the formula reported in the Commission of the European Communities Brussels [33]. Qualitative traits of carcasses, such as skin damage and the presence of breast blisters, were recorded.

Data were analyzed with a linear model [34] to evaluate the effect of strain. The significance of differences ($P < 0.05$) was evaluated by t-test.

RESULTS AND DISCUSSION

The Ross strain had a growth rate much greater than that of the Ancona crossbred strain (Table 1). The final BW of slow-growing chickens was less than 2 kg, whereas fast-growing birds reached approximately 4.5 kg. At slaughter, the Ross broilers reached the highest BW, with a high feed-to-gain ratio and mortality rate.

The main behaviors of the birds are presented in Table 2. Fast-growing birds tended to stay indoors rather than forage in the pasture, whereas slow-growing birds spent more time outdoors ($P < 0.05$). Fast-growing birds spent more time in lying and standing behaviors. Slow-growing birds were more active, showing higher values

Table 1. Performance of organically reared chickens[1]

Item	Fast growing	Slow growing	Pooled SE
Final BW, g	4,548^a	1,982^b	456
Feed intake, g/d	160.9^a	90.2^b	25.4
Daily BW gain, g/d	55.5^a	24.0^b	13.5
FCR	2.9^b	3.8^a	0.5
Mortality, %	10.0^a	5.0^b	2.0 (χ^2)

^{a,b}Means within rows having different superscripts differ significantly at $P < 0.05$.

[1]n = 100/genotype.

Table 2. Main observed behaviors of organically reared chickens[1]

Time spent, % of total	Fast growing	Slow growing	Pooled SE
Outdoors	30.0[b]	70.0[a]	15.9
Moving	3.0[b]	28.6[a]	9.7
Lying	24.6[a]	15.5[b]	8.1
Standing	40.5[a]	14.9[b]	13.2
Eating	9.5[a]	4.4[b]	4.7
Ground pecking	3.5[b]	12.5[a]	4.3
Wing flapping	0.1[b]	0.7[a]	0.3
Others	18.8[b]	23.4[a]	3.2

[a,b]Means within rows having different superscripts differ significantly at $P < 0.05$.

[1]n = 20/genotype.

for moving and lower values for lying. Ground pecking, wing flapping, and other behaviors were also higher in slow-growing birds.

Focal bird sampling method observations confirmed GPS records in that slow-growing birds performed more active behaviors, spent less time standing, and spent more time outdoors than indoors ($P < 0.05$). Based on GPS tracks, slow-growing chickens covered an average daily distance of 1,230 m, whereas fast-growing birds covered only 125 m (Table 3).

The frequencies of footpad lesions and of breast blisters are shown in Table 4. The incidence of FPD lesions was dramatically higher in fast-growing compared with slow-growing chickens. In fact, more than 70% of fast-growing birds had the maximum FPD score, whereas the minimum FPD score was reached in only 1.05% of slow-growing birds. The occurrence of breast blisters was noticeably higher in fast-growing birds than in slow-growing birds (0%).

Foraging on pasture is important in organic poultry production. Moreover, European Union organic rules ban the use of synthetic vitamins and amino acids, making it crucial that birds feed outdoors in the pasture to partly supply themselves with these compounds. Castellini et al. [6] found less protein and energy and higher amounts of α-tocopherol and carotenoids in the crop contents of slow-growing chickens, which we interpreted to mean a greater ingestion of grass by slow-growing chickens compared with fast-growing birds.

In behavioral studies, resting (lying and standing behaviors) accounted for 80 to 90% of the time budget of chickens [35], and 6- to 10-wk-old broilers spent 79 to 89% of their time lying down, including those reared more slowly and given access to pasture [10]. In this study, we demonstrated that foraging may have been considerably reduced in meat-type birds [36]. Similarly, Weeks et al. [37] found that the high level of lying down was related to the BW and fast growth rates of meat-type chickens. Schütz and Jensen [38] found that genetic selection of poultry for a high growth rate has progressively modified their behavior, reducing kinetic activity, which represents a main energy cost to the birds. According to Siegel and Wisman [39], selection for increased BW is associated with an increase in appetite; indeed, we observed that the percentage of eating in fast-growing birds was twice as high as that in slow-growing birds. Rest and sleep are strongly associated with energy conservation, tissue restoration, and growth [40, 41]. Such findings help explain why meat-type birds are more efficient feed converters than laying hens and slow-growing strains [42, 43].

In extensive housing conditions, slow-growing birds showed more adaptive behavior,

Table 3. Global positioning system outcomes of organic chickens[1]

Item	Fast growing	Slow growing	Pooled SE
Overall daily distance, m/d	125[b]	1,230[a]	120
Maximum distance from house, m	25[b]	100[a]	14
Time spent outdoors, %	25.6[b]	74.9[a]	25.7
Mean speed, m/h	8.93[b]	95.71[a]	30.5

[a,b]Means within rows having different superscripts differ significantly at $P < 0.05$.

[1]n = 10/genotype.

Table 4. Percentages of footpad dermatitis and breast blisters in organic chickens[1]

Item	Fast growing	Slow growing
Footpad dermatitis,[2] %		
Class 0	3.33	98.95
Class 1	25.56	1.05
Class 2	71.11	0
Breast blisters, %	73.33	0

[1]n = 90 for fast-growing slaughtered birds; n = 95 for slow-growing slaughtered birds.

[2]Score classes: 0 = no mark (no lesion), 1 = mild lesions (superficial lesions, erosions, papillae, and discoloration of the footpad), or 2 = severe lesions (deep lesions, ulcers, and scabs) [32].

moving around outdoors and ground pecking to forage; these findings were also confirmed by the great distance covered, as observed by GPS monitoring. The very low frequencies of foot and breast damage found at slaughter in slow-growing birds could provide an alternative explanation for their better adaptability. In fact, birds in good physical condition could perform more locomotor activity. On the contrary, the high incidence of FPD in fast-growing birds may explain their low activity. Moreover, these lesions are caused by the fact that as the birds get heavier, it might hurt them to keep standing up and moving, so they spend much of their time lying on the litter [9, 44].

CONCLUSIONS AND APPLICATIONS

1. In conclusion, use of a GPS could be a suitable way to evaluate the kinetic activity of chickens. In this study, behaviors that are high in energy cost, such as moving activities, were less frequent in the fast-growing birds compared with the slow-growing birds, allowing the fast-growing birds to save energy that could be reallocated to production traits.
2. We characterized fast-growing meat-type birds as very inactive, quite distinct from slow-growing birds. At ages older than they have been selected to live (approximately 45 d), these birds, in addition having alterations in ethograms, show other problems, such as FPD and breast blisters.
3. It is possible to affirm that this kind of bird is not useful in organic poultry systems, where greater space allowances are provided to birds along with low-protein feed, which is inadequate for fast-growing birds. Organic rearing does not reduce the welfare problems of fast-growing birds; on the contrary, these problems become more consistent.
4. The focal bird sampling method presents temporal (time availability for observers) and spatial (high pasture, bushes, trees) restrictions, whereas the GPS method guarantees continuous spatial monitoring of activity for the life (3 to 6 d) of the transmitter batteries, updating records of covered distance, stop times, speed, and direction.
5. In the organic rearing method, where birds are given large space allowances, this system could be useful to monitor bird activity and to predict the presence of health problems based on this information. Moreover, because this information is in electronic form and is transferable to the bar code at the site of the seller, it could give greater assurance to consumers regarding the welfare of the bird and the quality of the product [45].

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