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The effects of access to pasture on growth performance, behavioural patterns, some blood parameters and carcass yield of a slow-growing broiler genotype

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ABSTRACT

The aim of the present study was to determine the effects of access to a pasture on growth performance, behavioural patterns, some blood parameters and carcass yield of a slow-growing broiler genotype. A total of 210 one-day-old male chicks of Hubbard ISA Red JA were used in the experiment. At the 84th day, live weight was determined to be lower in the outdoor rearing system ($P < .01$). Better feed conversion ratio was found in the indoor rearing system ($P < .01$). The behaviour of the broilers was compared by observing the behaviour of three randomly selected marked birds on video tape. Eating, drinking, preening, spot pecking, feather pecking, walking-standing and resting-lying were monitored. Broilers from the outdoor rearing system group showed more preening, drinking, spot pecking, walk-stand and feather pecking behaviours as a result of increasing activity. Ratio of breast and thigh (carcass weight%) was higher, whereas abdominal fat was lower in the outdoor group. As a result of this study, access to a pasture improved the behaviours of broilers.

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KEYWORDS
Pasture; slow growing; broiler; behaviour; carcass yield

1. Introduction

In recent years, demands for greater meat quality and higher welfare standards have increased around the world. As a result of consumers' requests, the alternative systems, for example, free-range, Label Rouge and organic production systems, have been developed for broiler meat production (Sales 2014). Basic conditions of these systems are prohibition of antibiotics for growth and synthetic substances, and providing of access to outdoor called as pasture (Fanatico et al. 2006). These production systems have to meet minimum husbandry standards such as: a slow-growing bird, foodstuffs low in fats and high in cereals (at least 65–70%), low stocking rates (maximum of 11 birds/m^2) and a pasture area of 2 m^2 per bird, minimum slaughter age 81 days (Saveur 1997; Fanatico 2002).

Considering all of these factors, the alternative systems have a critical role for increasing the welfare status and decreasing stress conditions compared to conventional systems (Blokhuis et al. 2000). An opportunity access to pasture gives broilers the ability for walking and using their muscles (Remignon & Culioli 1995), so that quality and flavour of meat improve (Wang et al. 2009; Chen et al. 2013). Based on these cases, many consumers consider that broiler meat that is produced in alternative systems has excellent sensory qualities such as flavour, odour and taste (Latter-Dubois 2000; Castellini et al. 2002a). Therefore, consumers prefer these products and buy them with pleasure although it is more expensive. So that, some welfare indicators, for example, blood parameters, especially heterophil/lymphocyte ratio (H/L ratio) and internal organ weights, have to be taken into consideration for assessment of animal comfort and welfare (Campo et al. 2007).

In alternative systems slow-growing broiler genotypes should be used than fast-growing genotypes that have a lower adaptation ability (Reiter & Bessei 1998; Castellini et al. 2002b; Branciari et al. 2009). Free range system has enrichment as a habitat area that is covered by vegetation for the broilers with free access (Chen et al. 2013). Accessing a pasture provides possibilities for broiler to exhibit their natural behaviours, for example, scratching, foraging, dust bathing, sun bathing, perching and activity. In this way, development and strength of bones are developed well and leg problems can be prevented largely (Mikulski et al. 2011). While enrichment environmental conditions with higher welfare standards are maintained for slow-growing broilers, performance parameters like feed conversion ratio deteriorate compared to the conventional rearing system. Because pasture has a high fibre content and may be a factor for restricting utilization of other nutrients. As a result, it causes a reduction in feed efficiency and growth rate (Ponte et al. 2008a).

There are a lot of factors that effect the welfare status, behavioural patterns and broiler performance, such as rearing systems, genotype, sex, feed ration, stocking density, environmental conditions and physical activity (Butterworth et al. 2002; Gordon & Charles 2002). There is lack of studies that investigated the variations between rearing systems for slow-growing genotypes. It is known that fast-growing broilers have an adaptation ability for narrower conditions, but these ability is unclear for slow-growing broilers. So, the aim of the present study was to determine the effects of access or non-access (indoor rearing) to a pasture or the rearing system on performance parameters, carcass yield and behavioural patterns of slow-growing genotype.

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2. Material and methods

2.1. Birds, housing and diet

In the study, a total of 210 male one-day-old chicks of a slow-growing genetic line (Hubbard ISA Red JA) were used. One-day-old chicks were weighed by using a balance at ± 0.1 g precision at the beginning of the trial, and wing numbers were put on the chicks. Chicks were randomly allocated into 6 pens (3 replicates of 35 chicks per pen/each treatment groups) with a floor area of 2.5×2.0 m^2 (stocking density 0.14 m^2/bird). In pens for having access to pasture, indoor and outdoor areas were separated by a wall with a small hole. For the outdoor group, a pasture area (2 m^2/bird) was provided and covered with about 30% Alfalfa (*Medicago sativa*), 10% White clover (*Trifolium repens*) and 60% Perennial ryegrass (*Lolium perenne*). The broilers were supplied ad libitum access for feed and water throughout the experiment. Feed was supplied inside by hanging feeders in each pen, and water both inside and pasture. Woodshaving was used as the litter material on the floor of the pens. Lighting programme was applied according to management guides.

The study was performed between June and September when the weather was hot and did not fluctuate widely. Outdoor temperature ranged from 15°C to 32.2°C during the period when the birds had outdoor access, indoor temperatures only varied from 15.5°C to 28.8°C.

A diet that had low fat content and high cereals content and free from growth promoters and animal protein was used. The composition and feeding value of the diets were ascertained by using the Weende analysis (AOAC 1990) according to management guides. The broilers in groups were fed with a starter diet (22.0% CP and ME 12.8 MJ/kg) between the 1st and 28th days and a grower diet (20.00% CP and ME 13.2 MJ/kg) between the 29th and 84th days (Table 1).

Table 1. Ingredient composition and feeding value of the treatment group's diets (%).

Ingredient	Starter diet	Grower and finisher diet
Corn grain	47.2	50.2
Wheat grain	15.7	16.3
Soybean meal	32.3	25.7
Plant oil	0.75	3.75
Calcium carbonate	1.00	1.00
Dicalcium phosphate	1.50	1.50
Salt	0.30	0.30
Premix[a]	1.00	1.00
Methionine	0.18	0.18
Lysin-HCl	0.06	0.06
Analysis		
Organic matter	93.4	93.4
Crude protein	22.0	20.0
Crude fibre	6.8	6.8
Ether exract	6.2	8.6
Crude ash	6.6	6.6
Nitrogen free exract	51.8	51.5
ME, MJ/kg	12.8	13.2

Note: Starter diet was used between days 1 and 28; grower and finisher diet between days 29 and 84.

[a]Mixture (per kilogram of diet): 2250 U vitamin A (retinyl acetate); 450 U vitamin D3 (cholecalciferol); 700 U vitamin E (DL-α-tocopheryl acetate); 418 U vitamin K3 (menadione dimethylpyrimidinol); 300 mg vitamin B1 (thiamine mononitrate); 2300 µg vitamin B12 (cyanocobalamin); 7000 mg niacin (niacinamide); 2500 mg calcium pantothenate; 140 mg folic acid; 14 mg D-biotin; 12.5 g Fe (iron sulphate monohydrate); 3000 mg Cu (copper sulphate pentahydrate); 250 mg I (calcium iodate); 12.5 g Zn (zinc oxide); 15 mg Mn (manganous oxide); 75 mg Se (sodium selenite); 50 mg Co (cobalt sulphate).

2.2. Growth performance

During experiment, live weight gain values were monitored through weekly individual weighings until the end of the 84th day, feed conversion ratios were calculated using the live weight gains and feed consumption values. The mortality values in each pen were recorded daily on the pen charts and the mortality rates in the groups were determined depending on these data.

2.3. Behavioural measurements

For determining behavioural characteristics of broilers, the back of three birds from each pen was painted with green colour paint. Painting of broilers was repeated frequently during the experiment. In this study, video observation was used to monitor the behaviour of the painted broilers in each pen and pasture area. Broilers were monitored twice (at 4th and 8th weeks) during the experiment weeks and were videotaped during light exposure time. On each observation day, video recording was started at 09:00 am for 180 min and at 15:00 pm again. The video recordings were monitored using the instantaneous sampling procedure (Lehner 1996). Behavioural characteristics were eating, preening, drinking, spot pecking, feather pecking, walking-standing, resting-lying and other behaviour. The behaviour definitions were performed according to Zhao et al. (2014) (Table 2). The broilers also were observed with binoculars from outside the paddocks to avoid the possibility of disturbing their behaviour. Observations were performed in a certain area for each recording. Behavioural characteristics were expressed as a percentage of total occurrences.

2.4. Blood parameters

At slaughter age, blood samples were taken from six broilers from each treatment group for the determination of haematocrit, heterophil, lymphocyte, eosinophil, basophil, monocyte and the H/L ratio. Blood samples were immediately centrifuged at 3000 rpm for 10 min. Hemoglobin and haematocrit analyses were performed according to cyano methaemoglobin and microhaematocrit methods (Merck 1974). Following the technique of the May Grünwald–Giemsa method, leukocyte per cents were calculated (Gross & Siegel 1983).

Table 2. Behaviours and definitions.

Behaviours	Definitions
Eating	Broilers contact their beaks to feed and perform eating/pecking repeatedly/once
Drinking	Broilers contact their beaks to drinkers and raise their head when drinking water
Preening	Broilers contact their beak to plumage of different body parts (e.g. abdomen, shoulder, wings, back) by movements of pecking, combing, rotating, nibbling once or repeatedly
Feather pecking	Broilers peck others' feathers
Walking	Broilers move with a normal or quick speed
Standing	Broilers stand in a stable position
Resting-lying	Broilers lay on their abdomen or their legs are under body

2.5. Slaughter and carcass yield

A total of 60 broilers (30 broilers per each treatment group) were selected randomly at 84 days for the slaughter process. Feed was withdrawn 12 hours before slaughter. Broilers were individually weighed to determine slaughter weight and then were slaughtered in a processing plant of the university farm. After slaughter, broilers were scalded at 53°C for 120 s prior to plucking (Fanatico et al. 2005), followed by manual evisceration. Carcasses were prechilled in water at 12°C for 15 min and chilled at 1°C for 3 h and then carcasses were weighed. The carcass weight was calculated by removing the feathers and blood, and the eviscerated weight was calculated by removing the head, feet and organs, except the lungs and kidneys. The carcass yield was then expressed as a percentage of slaughter weight. Abdominal fat pad was removed and the organs (heart, liver, gizzard, spleen) were individually weighed. Then the carcasses were divided into primal pieces (breast, thigh + drumstick, wing) according to the method described by the Regulation on Poultry Meat Quality (Raseta & Dakic 1984). The thighs and drumsticks were removed from the carcass by cutting above the thigh, towards the acetabulum and behind the pubic bone. Then, the drumsticks were separated from the thighs by cutting perpendicular to the joint between the drumstick and thigh bones. The wings were removed by the so-called 'shoulder' incision through the joint (articulation) surfaces of the scapula and the coracoid. The breast was separated by a cut perpendicular to the ventral joints of ribs, the 'rib' incision. Then the carcass pieces were weighed and measured for percentage of cold carcass weight.

2.6. Statistical analyses

The data of live weight, live weight gain, feed consumptions, cumulative feed consumption, feed conversion ratio, blood parameters and carcass yield are analysed by the general linear model of Statistical Analysis Software (SAS 1989) using Duncan's multiple range test to compare the treatment means. Mortality data were analysed using chi-square. Data of behavioural measurements, arcsin transformation were conducted before analyses. The percentage of time spent on each behaviour was calculated for behavioural data (Ruis et al. 2004). All results were presented as mean ± SD at significant $P < .05$.

3. Results

The effect of the rearing system on live weight, live weight gain, feed consumption, cumulative feed consumption, feed conversion ratio and mortality rate is given in Table 3. The effect of the rearing system on live weight was found to be significant except on days 1 and 7. The live weight during the rearing period was determined to be lower in the outdoor rearing system ($P = .001$). Live weight gain was found to be significant for 14th, 21st, 42nd and 63rd days of the rearing period ($P < .05$). Whereas feed consumption was found to be higher on the 21st day in broilers of the indoor group, on the 42nd day in broilers of the outdoor group ($P < .01$). Accordingly, while higher cumulative feed consumption was found in the indoor rearing system on the 21st, 42nd and 63rd days, higher cumulative feed consumption was observed in the outdoor rearing system on the 84th day. The best feed conversion ratio was determined in the indoor rearing system on the 84th day.

The effect of rearing systems on percentage of behaviours of slow-growing broiler genotype in the different rearing management systems is given in Table 4. Also, the range of behaviours in the systems is shown in Figure 1. Significant differences were observed between behaviours in the groups ($P < .01$). A higher percentage of eating and resting-lying behaviours was observed in the indoor rearing system, whereas a higher percentage of drinking, preening, spot pecking, feather pecking and walking-standing was observed in the outdoor rearing system.

The effect of rearing systems on some blood parameters is given in Figure 2. Haematocrit, heterophil, lymphocyte,

Table 3. Means values of the live weight, growth rate, feed consumption, cumulative feed consumption, feed conversion ratio and mortality rate for two different rearing systems (mean ± SEM).

		Age (day)						
Variables	Rearing systems	day 1	day 7	day 14	day 21	day 42	day 63	day 84
Live weight (g/bird)	Outdoor	44.5 ± 0.7	97.8 ± 2.3	230.6 ± 6.0	563.3 ± 26.5	1483.7 ± 89.5	2122.9 ± 158.5	2780.4 ± 154.4
	Indoor	44.3 ± 0.7	99.4 ± 2.5	240.7 ± 6.2	695.5 ± 29.3	1742.7 ± 96.1	2340.7 ± 169.5	2986.8 ± 178.2
P-value		NS	NS	.025	.032	.001	.001	.001
Live weight gain (g/bird)	Outdoor	-	53.3 ± 1.4	132.8 ± 4.0	332.7 ± 16.1	920.4 ± 65.4	639.2 ± 37.8	657.5 ± 35.2
	Indoor	-	55.1 ± 1.5	141.3 ± 4.8	454.8 ± 20.2	1047.2 ± 72.3	598.0 ± 30.2	646.1 ± 40.4
P-value			NS	.038	.001	.017	.043	NS
Feed consumption (g/bird)	Outdoor	-	96.4 ± 3.7	168.2 ± 18.4	510.4 ± 26.6	1897.3 ± 136.4	2220.6 ± 135.8	3116.0 ± 158.5
	Indoor	-	97.1 ± 4.1	165.5 ± 12.4	730.1 ±± 42.1	1880.4 ± 130.8	2189.3 ± 149.1	2701.5 ± 172.9
P-value			NS	NS	.012	NS	NS	.001
Cumulative feed consumption (g/bird)	Outdoor	-	-	264.6 ± 47.5	775.0 ± 57.7	2672.3 ± 157.1	4892.9 ± 185.7	8008.9 ± 204.1
	Indoor	-	-	262.6 ± 52.1	992.7 ± 81.8	2873.1 ± 183.2	5062.4 ± 184.3	7763.9 ± 197.3
P-value				NS	.001	.042	.038	.041
Feed conversion ratio	Outdoor		0.98 ± 0.1	1.14 ± 0.1	1.37 ± 0.1	1.80 ± 0.1	2.30 ± 0.1	2.86 ± 0.1
	Indoor		0.98 ± 0.1	1.09 ± 0.1	1.42 ± 0.1	1.65 ± 0.1	2.16 ± 0.1	2.60 ± 0.1
P-value			NS	NS	.046	.001	.001	.001
	1–84 day							
Mortality rate (%)	Outdoor	1.90 (2/105)						
	Indoor	2.85 (3/105)						
Chi-Square		0.205						
P-value		NS						

Note: Numbers in the parentheses are no. of dead birds/total no. of birds.

Table 4. The percentage of behaviours in the different rearing management systems (%) (mean ± SEM).

	Rearing systems		
Behaviours	Outdoor	Indoor	*P*-value
Eating	17.2 ± 0.2	18.7 ± 0.2	.001
Drinking	3.2 ± 0.0	3.1 ± 0.0	.001
Preening	1.2 ± 0.1	1.0 ± 0.1	.001
Spot pecking	6.4 ± 0.1	5.7 ± 0.1	.001
Feather pecking	2.9 ± 0.0	2.6 ± 0.0	.001
Walking-standing	14.2 ± 0.2	12.2 ± 0.2	.001
Resting-lying	54.7 ± 0.7	56.7 ± 0.7	.001

Note: For behavioural characteristics of birds, back of three birds/pen was painted with green colour.

eosinophil, basophil, monocyte and H/L ratio were found to be similar among treatment groups ($P > .05$).

The effect of rearing systems on the mean yield of carcass, parts, and organs is given in Table 5. Whereas rearing systems affected significantly the breast yield, thigh yield and abdominal fat ($P < .05$), it did not affect significantly the carcass yield, wings, liver, gizzard and heart yield which were found to be insignificant ($P > .05$). As expected, a higher breast yield and thigh yield and lower abdominal fat content were found in the outdoor rearing system.

4. Discussion

In our study, outdoor access affected broiler growth performance. On day 84, a lower live weight with a worse feed conversion rate was observed in broilers in outdoor groups in accordance with other studies (Castellini et al. 2002a, 2002b; Wang et al. 2009). In contrast to our results, outdoor access did not affect the growth performance in previous studies (Jiang et al. 2011; Mikulski et al. 2011; Chen et al. 2013). Our findings could be explained by some factors in the outdoor system such as environmental temperature, exercise, pasture intake (Chen et al. 2013). Pasture intake has an exacerbate effect on performance parameters, especially the feed conversion rate. Because pasture has a high fibre content, it has a restricting effect on utilization of other nutrients (Ponte et al. 2008a). Similar results with a lower live weight with worse feed conversion rate were also observed in this study. On the other hand,

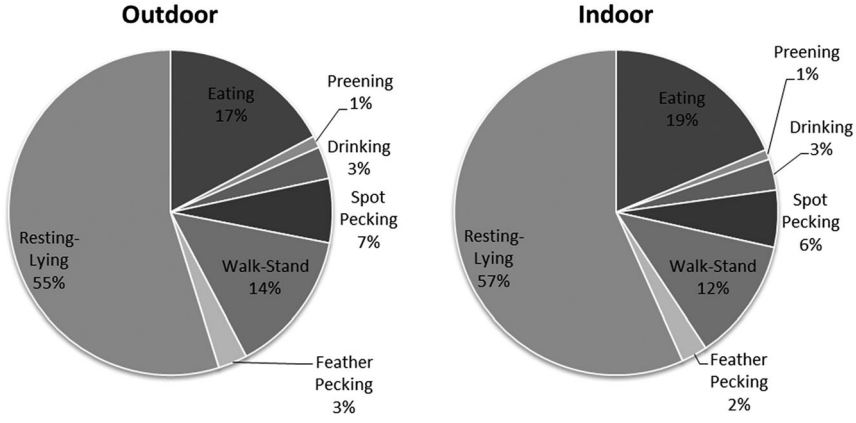

Figure 1. Range (%) of behaviours in outdoor and indoor rearing systems.

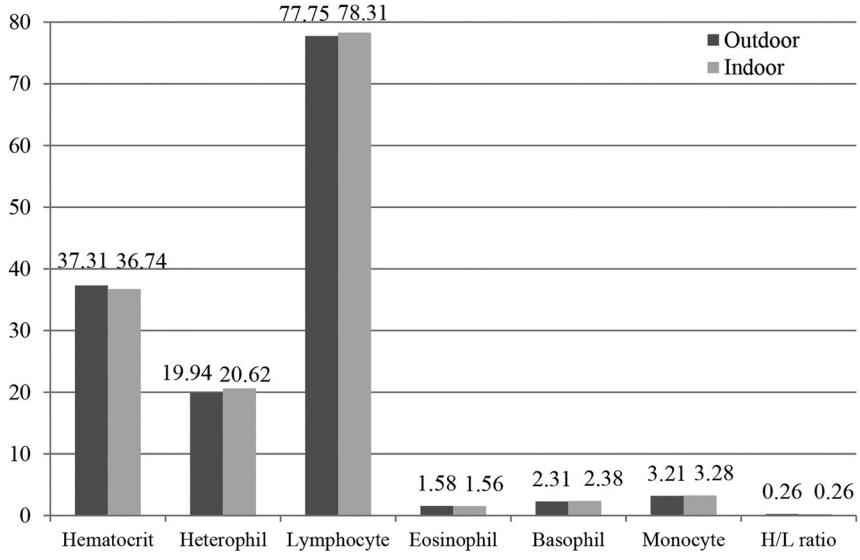

Figure 2. Effects of access to pasture on blood parameters.

Table 5. The effects of rearing systems on mean yield of carcass, parts and organs (%)(mean ± SEM).

	Rearing systems		
Variables	Outdoor	Indoor	*P*-value
Carcass yield	72.8 ± 1.2	72.6 ± 1.2	NS
Breast yield	27.8 ± 0.8	26.7 ± 0.8	0.047
Thigh yield	15.8 ± 0.1	15.2 ± 0.1	0.046
Wing yiels	12.3 ± 0.9	12.4 ± 0.9	NS
Abdominal fat	2.1 ± 0.0	2.6 ± 0.0	0.001
Liver	1.4 ± 0.7	1.3 ± 0.9	NS
Gizzard	2.3 ± 0.9	2.2 ± 0.8	NS
Heart	0.6 ± 0.9	0.5 ± 0.8	NS

Note: For carcass, parts and organs yield, a total of 30 broilers from each group was randomly sampled.

the environmental temperature affects the growth performance. Cold temperatures increases feed consumption, while hot temperatures reduce feed consumption. Feed intake is increased at cold temperatures and reduced at hot temperatures (Gordon & Charles 2002). Therefore, this study was performed during warmer season to avoid the effects of temperature on growth performance.

This study clearly showed that access to a pasture affects behavioural patterns of slow-growing broilers by means of increasing activity and exhibiting natural behaviours. As previously reported (Zhao et al. 2014), behaviours such as preening, spot pecking, walking-standing were observed with a higher occurrence in fast-growing broilers with outdoor access than the indoor group. Accessing of outdoor induces broilers to explore their environment, so behaviours, locomotor activity and especially leg health are improved by increase in exercises. It could be verified by finding in this study that leg problems were found to be higher in the indoor group than the outdoor group (9.7% and 0.9%, respectively, chi-square = 6.811, $P = .009$; unpublished data). Activity and exercise result in increasing of feed consumption and worsening of feed conversion rate (Fanatico et al. 2008). In this study, these results are supported by findings of growth performance. On the other hand, behaviours of eating and resting-lying were observed with a higher occurrence in the indoor group. It could be explained by restricted area and less activity in the indoor group (Zhao et al. 2014).

It is known that stress conditions affect the H/L ratio and leukocyte count (Gross & Siegel 1983; Puvadolpirod & Thaxton 2000). Under stress conditions, the number of lymphocyte, eosinophil, monocyte and haematocrit values shows a decline, whereas the number of basophil and heterophil increases. On the other hand, especially elevated temperatures cause a decline in blood volume and haematocrit value (Altan et al. 2000). In this study, the temperature did not fluctuate widely, so birds were not exposed to high stress levels. Thus, blood parameters were found to be similar between experimental groups. Nonetheless, similar rectal temperatures in indoor and outdoor groups (41.57°C vs. 40.87°C) supported this finding.

Results of this study showed clearly that accessing a pasture also has an effect on yield of carcass parts and abdominal fat. On the other hand, carcass yield was found to be similar, and was supported findings of Sales (2014) who found similar results. Higher percentage of breast and thigh yields may be explained by effects of the outdoor rearing system on activity (Ponte et al. 2008b) and locomotor activity (Castellini et al. 2002b; Wang et al. 2009). In contrast, in our results it was concluded that outdoor access did not affect carcass and part yields (Fanatico et al. 2005; Wang et al. 2009; Jiang et al. 2011). Besides, in the outdoor group as a result of activity, abdominal fat was found to be lower than the indoor group. Conversely, it was reported that access to outdoor did not have an effect on abdominal fat (Grashorn & Brose 1997; Mikulski et al. 2011).

5. Conclusion

Recently, as a result of increasing demands for healthy and safe food, alternative production systems have gained more importance in the poultry industry. At this point the free range system is an important alternative than the conventional production system. In this study, it was found that outdoor access was beneficial for behaviours of broilers, nevertheless had a deteriorating effect on live weight gain and feed conversion rate. So, this production system should be investigated in more detail in different rearing variables considering positive and negative advantages with respect to conventional systems.

Disclosure statement

No potential conflict of interest was reported by the authors.

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