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The Rowan Ranger Chicken Breed – a Suitable Alternative for the Organic Chicken Meat Industry

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Sammanfattning
Abstract

The only available broiler strain to use in organic chicken meat production, until recently, has been conventional fast growing broiler hybrids. The Rowan Ranger is a broiler strain that has a naturally slower growth rate which makes this strain suitable for organic farming, meeting the demands of KRAV without being subjected to a feed restriction. One of the farms in Sweden using Rowan Ranger in their organic production is Bosarp farm in Skåne County where they produce KRAV certified chickens and where the animals used in this study were raised. This study compared differences between a naturally slow growing strain of chicken to a fast growing strain to see whether there were differences in behaviour between the two, if one of the strains was more susceptive to stress than the other and whether they differed in outdoor use and activity level. Regardless of strain, chickens used the outdoor perimeter the same, although the Rowan Rangers did not range as far from the chicken house as Ross 308. Even so, they seem to be more suitable in an organic setting than Ross 308 due to the fact that they seem less hungry and more content, this based on the fact that they perform less feeding behaviour and spend more time laying down. Also, they grow nicely to slaughter weight with a good diet quality whereas Ross 308 need to be qualitative feed restricted to do the same, giving the Rowan Rangers better welfare.

Nyckelord
Keyword

Behaviour, Broiler, Chicken, Organic Production, Rowan Ranger

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1 Abstract

The only available broiler strain to use in organic chicken meat production, until recently, has been conventional fast growing broiler hybrids. The Rowan Ranger is a broiler strain that has a naturally slower growth rate which makes this strain suitable for organic farming, meeting the demands of KRAV without being subjected to a feed restriction. One of the farms in Sweden using Rowan Ranger in their organic production is Bosarp farm in Skåne County where they produce KRAV certified chickens and where the animals used in this study were raised. This study compared differences between a naturally slow growing strain of chicken to a fast growing strain to see whether there were differences in behaviour between the two, if one of the strains was more susceptive to stress than the other and whether they differed in outdoor use and activity level. Regardless of strain, chickens used the outdoor perimeter the same, although the Rowan Rangers did not range as far from the chicken house as Ross 308. Even so, they seem to be more suitable in an organic setting than Ross 308 due to the fact that they seem less hungry and more content, this based on the fact that they perform less feeding behaviour and spend more time laying down. Also, they grow nicely to slaughter weight with a good diet quality whereas Ross 308 need to be qualitative feed restricted to do the same, giving the Rowan Rangers better welfare.

Keywords: Behaviour, Broiler, Chicken, Organic Production, Rowan Ranger

2 Introduction

In EU, organic farming has increased by almost 50% during 2002-2011, however, it nevertheless constitutes only 5.4% of the total cultivated land in the EU (European Comission 2013). Sweden is, after Austria, the country in the EU which 2011 had the largest percentage of organically cultivated area, mainly consisting of permanent grassland, industrial crops and grains (European Comission 2013). Although demand for organic animal production is increasing, in 2010, the organic poultry only accounted for 1% of the poultry market in the EU (European Comission 2013). The demand for organic animal production increases as consumer concern increases over the use of antibiotics and pesticides and genetic modification of conventional grain production (Moritz et al. 2005).

As the proportion of organic farmers is still small scale in Sweden, the only available broiler strain to use in organic chicken meat production, up until now, has been conventional fast growing broiler

hybrids (Eriksson et al. 2010). These fast growing broilers are bred to produce a lot of meat in a short period of time, and along with an improved diet, the growth rate of our broilers has increased dramatically during the years (Zuidhof et al. 2014). Along with the selective breeding for a broiler that produces meat fast, there is an increased incidence of skeletal disease, which commonly is expressed in difficulty walking, but also as paralysis (Zuidhof et al. 2014), something that is undesirable for any chicken production.

According to KRAV (2013) the mean growth rate for organic chicken cannot exceed 50 g per day, a goal that today cannot be achieved using conventional broilers, such as Ross 308, that have an average daily growth rate of 61 g when fed *ad libitum* (Eriksson et al. 2010). Besides having a faster growth rate than accepted, keeping the conventional broiler in organic production means keeping them alive a minimum of 70 days (KRAV 2013), which is 30-39 days longer than praxis in conventional production (SIK-rapport 888 2014; Eriksson et al. 2010). The demand for a longer rearing period in organic production, together with having a fast growth rate, prove difficult to meet for the conventional broiler, who needs some kind of feed restriction to slow down its growth rate. This combination of a longer rearing period and a forced slower growth rate results in different welfare problems for the fast growing broiler. While a positive aspect of slower growth rate is a decrease in the occurrence of bone problems and a lower mortality (Leterrier et al. 2008), the negative aspect is that it will increase the proportion of unwanted behaviour, such as feather pecking and cannibalism, which arises primarily from hunger and frustration (Savory & Kostal 1996).

Rowan Ranger is a broiler strain that has a naturally slower growth rate than the conventional fast growing broiler hybrid Ross 308 (Aviagen 2014). According to Aviagen (who supply chickens to customers), the Rowan Ranger has a maximum growth rate of 45 g per day when fed *ad libitum*, which makes this strain suitable for organic farming, meeting the demands of KRAV without being subjected to a feed restriction. A recent study actually showed that Rowan Rangers grow 43 g/day up until day 42 (Damme et al. 2015). The development of the Rowan Ranger started in 2004 in Scotland, but it is now being bred in other countries in Europe (Bjärefågel 2014). In Sweden, SweHatch was the first facility to introduce the strain in cooperation with Bjärefågel (Bjärefågel 2014).

The Rowan Ranger seems to be the answer to the organic chicken industry's needs. Therefore it is interesting to actually test and evaluate if this is indeed the truth, something this study set out to do with a series of

test regarding behaviour and stress. It would be presumed that using a slow growing strain in organic production will improve animal welfare, an aspect that is of growing concern among consumers as awareness of product quality increases. As a continuation, it would also be of importance to evaluate the Rowan Rangers performance in Sweden.

This study will, perform different experiments to evaluate differences in behaviour and fearfulness between the naturally slow growing Rowan Ranger and the fast growing Ross 308. Fear is a negative emotion associated with stress and can be measured by the duration of induced tonic immobility, which is an innate state of paralysis in chickens and a well-studied phenomenon (Forkman et al. 2007; Wang et al. 2013) and one of the experiments part of this study. The longer the duration of tonic immobility, the higher level of fearfulness and the higher risk of chronic stress (Wang et al. 2013).

This study will also perform a social isolation test analysing vocalization patterns. Chickens are generally said to be social animals and they use their wide repertoire of vocalizations as a social tool (Marx et al. 2001). When isolated from the group, the chick normally tries to reinstate contact with its conspecifics by using its vocal repertoire to call for assistance, especially by using distress vocalization (Collias 1987; Marx et al. 2001). Whilst distress calls are usually vocally expressed during social isolation, fear trills is often expressed awaiting danger (Marx et al. 2001).

Organic, free-ranging systems for chicken egg- and meat production requires outdoor opportunities (KRAV 2013), and because of this, chickens' were equipped with loggers measuring light and activity bouts to see whether or not there is a difference between the two broiler strains in the use of the outdoor perimeter.

The hypothesis of my work are (1) that the two strains of chicken will perform the same type of behaviours but with different time budgets, and (2) that Ross 308 will have a higher activity level and perform more feeding behaviour than Rowan Rangers. This based on the hypothesis that the Ross 308, being feed restricted, is motivated by hunger to constantly be in search of food compared to Rowan Rangers.

The aim for this study is to provide a better understanding of the behaviour of the Rowan Ranger and serve as basis for future studies in Sweden.

3 Material & methods

3.1 Animals

One of the farms in Sweden using Rowan Ranger in their organic production is Bosarp farm in Skåne County, where they produce KRAV certified chickens. The data collection took place during the autumn 2015. The animals used in this study, 72 Rowan Rangers and 20 Ross 308, were all raised at Bosarp farm, fed *ad libitum* and had free access to water. Due to the fast growth rate, Ross 308 were fed *ad libitum* but were qualitative feed restricted as a way to slow down their growth rate (Eriksson et al. 2010; Sahraei 2012). A qualitative feed restriction can be to give a low protein diet or a low energy diet (Eriksson et al. 2010; Sahraei 2012). At Bosarp, both strains were given the same starter-feed but from day 20-70, Ross 308 were given a feed that consisted of lower protein and higher solids. The feed given to the Ross 308 were also mealier in consistence then the feed given to the Rowan Rangers, which were more pelleted. The mealy substance changed the feed intake as it was harder to eat and Ross 308 had to work harder to eat large amounts.

The chickens were all kept in flocks of approximately 1200-1600 individuals per house according to Swedish legislation and KRAV standards (KRAV 2013). The 72 Rowan Rangers were divided in two age groups of 36 animals in each group (5 and 8 weeks old). The group of 20 Ross 308 were 8 weeks old. All animals were weighed using a BW-2025 poultry weigher (Weltech International Ltd., Cambridgeshire, England) and all test animals were exposed to the same experiments.

Both the Rowan Rangers and Ross 308 had free access to the outdoor perimeter during the day (Ross 308 from week 4 and Rowan Rangers from week 5). The light regime in the chicken houses was manually controlled and opened early in the morning and closed late afternoon. At the same time the hatch doors were opened and closed, the light in the chicken house was switched on and off.

3.2 Behavioural study

Behavioural data was collected using rotating focal sampling and continuous recording with an interval of 20 s for a total of 20 min per session to describe the behaviours of four focal individuals per session. This way, each behaviour in the ethogram (Table 1) could be observed a maximum of 60 times per session. The recorded behaviours in the ethogram got categorized and grouped before statistical analysis,

following the categories and groupings from a previous study (Eklund & Jensen 2011).

Continuous recording was chosen as method for this study since chickens can change behaviour quickly and with continuous recording fewer behaviours are missed. The rotating focal sampling was used to collect data at each 20 s time interval to determine how often a behaviour was performed during a sampling period.

Table 1. Ethogram containing functional and descriptive terms of behaviours, as well as their categorical grouping.

Functional tem	Abbreviation	Descriptive term	Category
Eating	E	Head in the feeder, pecking at food	Feeding
Drinking	D	Pecking on the drinking nipple or in the cup beneath the drinking nipple	Feeding
Ground pecking	GP	Pecking movements directed towards the ground	Feeding
Scratching	SC	Scraping in the litter using claws	Feeding
Dust bathing	DB	Lying with puffed feathers, rubbing head on the floor, wings outstretched and scratching at substrate	Dust bathing
Preening	P	Grooming own feathers using beak	Comfort
Stretching	STR	Extending of wing and/or leg	Comfort
Wing flapping	WF	Flapping of wings in a bilateral up-and-down matter	Comfort
Lying	L	Laying on belly with head flat to the substrate or with head beneath wing with open or closed eyes	Lying
Standing	S	Standing still, not moving	Activity
Walking	W	Moving forward in a slow pace or with quick steps	Activity
Aggression	A	Bird walks after a conspecific with head held high, the other bird walking/running/jumping away. Bird stands in front of a conspecific and flaps its wings more than once in front of the other bird at distance less than 0.5 m	Aggression
Other	O	All other behaviours not mentioned above	Other

A barrier that consisted of 16 compost grating units acted as a screen in one area of the house and dividing some animals from the rest (Figure 1). From these fenced in animals, 4 animals were then randomly chosen to participate in the behavioural data study as focal animals.

The percent time spent performing each noted behaviour during each session was calculated from the data, using summary values for all focal animals in each test group.

Figure 1. The compost grating units acts as a barrier, screening off a smaller area in the chicken house.

3.3 Activity loggers

Every day, six individuals were equipped with activity loggers (MotionWatch 8, CamNtech, Cambridge, UK) and worn for approximately 23 h. The chickens wore the activity loggers as backpacks which was made out of cohesive bandage and elastic rubber bands (Figure 2a). The rubber bands were placed over the chickens' wings and put to the wing base (Figure 2b). To eliminate the risk of re-testing, individuals were marked with plastic leg rings and colour spray (PORCIMARK marking spray, Kruuse) (Figure 2b).

a)

b)

Figure 2 a) The activity loggers measuring light and activity were wrapped in cohesive bandage with elastic rubber bands attached. b) The activity loggers was worn as backpacks for approximately 23 h, with the rubber bands put to the wing bases. The chicken wearing the logger was marked with plastic leg rings and a colour mark on the neck to eliminate the risk of re-testing the same individual.

The purpose for this experiment was to evaluate how much time the chicken spent outside their house and actually used the outdoor perimeter. This was made possible by programming the loggers to record light every second. The loggers was also set to record activity data every second (received as MotionWatch counts per set time epoch (MC s^{-1})).

3.4 Tonic immobility (TI)

Every day, individuals wearing loggers for the previous 23 h got collected in the early afternoon. At this time the chickens were weighed and subjected to both a tonic immobility test and a social isolation test. The chickens were tested individually one at a time in a dimly lit test room (6-9 lux), where they had no contact with other chickens. Here the chicken was individually placed on its back in a v-shaped wood construction (Figure 3a) by one and the same experimenter.

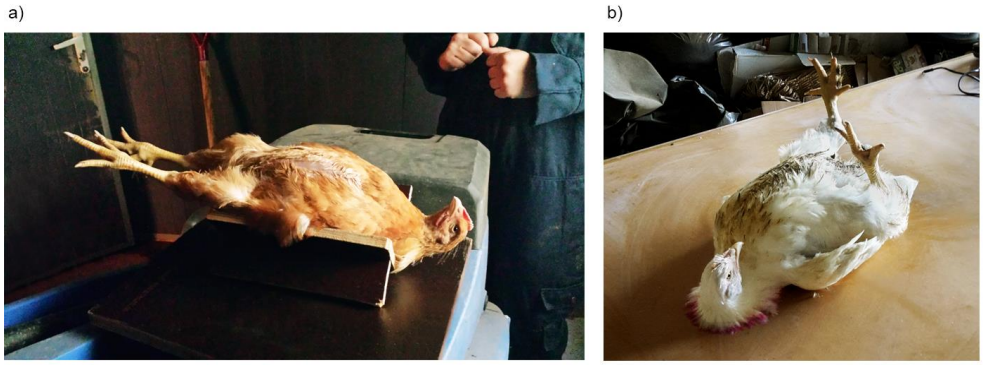

Figure 3 a) The 5 weeks Rowan Rangers were placed in a wooden v-shaped construction for inducing tonic immobility. b) The 8 weeks Rowan Rangers and 8 weeks Ross 308 were placed flat down on a table for inducing tonic immobility.

At 8 weeks, animals were placed on their back, flat down on a table instead (Figure 3b) in another test room with similar light intensity.

Tonic immobility was carried out using standardized procedures (Lindholm et al. 2015). After being placed on their back, the experimenter briefly restrained the chicken for 15 s, trying to induce tonic immobility. If the chicken was induced, and if the chicken did not arise itself within the maximum test limit of 5 min, tonic immobility was interrupted. The number of induction trials (1-3), time it took to turn to the right position (TI duration in seconds) and latency to first head movement (time in seconds to first distinct turning of the head) were recorded.

3.5 Social isolation

Chickens were individually placed in a cardboard box (576 x 346 x 407 mm.) at room temperature covered with a blanket to keep light from coming in (Figure 4a). Using a digital voice recorder (Olympus Digital Voice Recorder, Tokyo, Japan), the vocalizations from the isolated chicks were recorded during 5 min.

The sound analysis focused on “distress calls” (Figure 4b) and “fear trills” (Figure 4c) (Collias & Joos 1953; Collias 1987; Marx et al. 2001) which are relevant in a context of social isolation. Calls that could not be identified, or calls that were neither distress calls nor fear trills, were classed as “other calls”. The calls were differentiated using the categorization and description provided by Collias & Joos (1953), Collias (1987) and Marx et al. (2001).

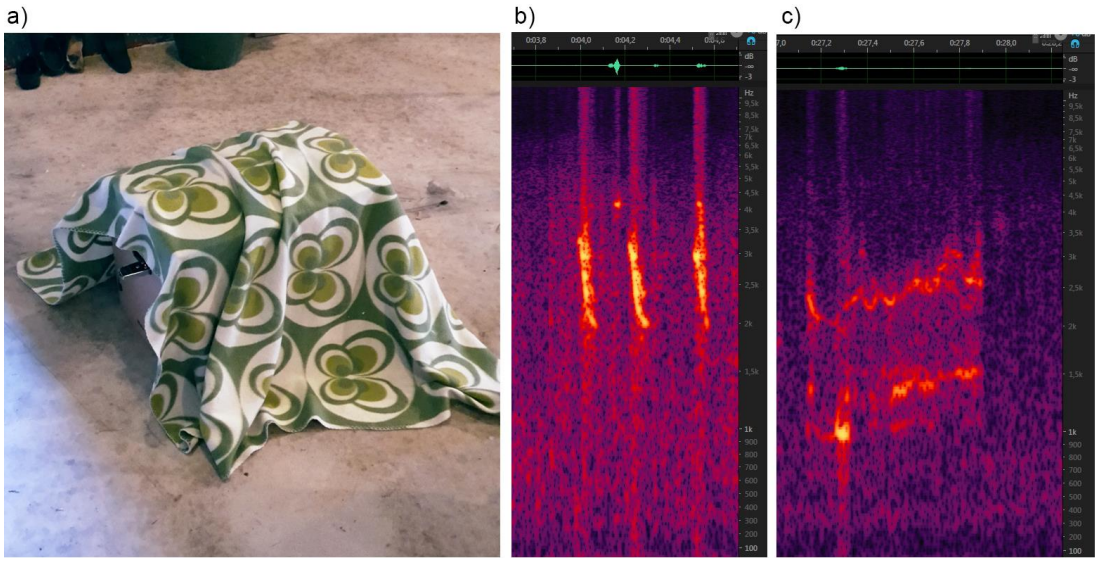

Figure 4 a) The chick was placed in a cardboard box covered with a blanket during the isolation test. b) A distress call shown by a spectrogram from the recordings during the isolation test. c) A fear trill shown by a spectrogram from the recordings during the isolation test.

Although all sounds did not look characteristic of those studies before me (Collias & Joos 1953; Collias 1987; Kruijt 1964; Marx et al. 2001), I identified a distress call by a sound that descended in frequency, was given in the region of 2-6.5 Hz and lasted for 100-250 ms (Marx et al. 2001). Fear trills have also descending frequencies but are given in successive cycles that trend downward in average frequency (Marx et al. 2001).

3.6 Novel object test (NOT)

The European Commission carried out surveys that confirmed that animal welfare is an important issue for consumers, and in collaboration with many institutes and research groups, then developed scientifically based tools as part of trying to standardize ways of assessing animal welfare (Welfare Quality® 2009). The Novel object test (NOT) used in this study is based on the Assessment protocol for poultry. The protocol states that negative emotions, such as fear, amongst the animals should be avoided and that instead one should strive for positive emotions, such as security and satisfaction (Welfare Quality® 2009).

The farm NOT method was carried out in the litter within the broiler house. The novel object (NO) used was a 51.2 cm long wooden stick with coloured plastic bands with a diameter of approximately 2.52 cm width (Figure 5a). The NOT followed procedures of the Welfare Quality® assessment protocol for poultry (Welfare Quality® 2009). Two experimenters both entered the broiler house and then stood waiting in chosen position for 5 min to let the birds settle, after which the NO was carefully placed on the litter floor and both experimenters stepped back 1.5 m. Immediately, the number of chickens at a distance of less than 1 bird length of the NO was noted every 10 s for a total of 2 min (resulting in 12 counts per location) (Figure 5b).

a)

b)

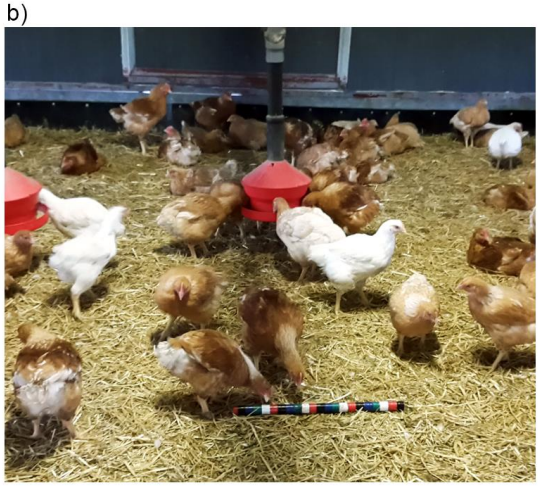

Figure 5 a) The novel object used in the novel object test. b) Rowan Rangers investigating the novel object during the novel object test.

3.7 Data analyses

Before subjecting any data to a statistical test, it underwent a Levene test for equal variances with the significant level set to 0.05 after which the type of statistical test was chosen based on the data having equal variance

or not. Statistical analysis was done using MiniTab® 17 software (MiniTab Inc, State College, PA, USA).

To test for differences in weight, a 1-way ANOVA was used after which a Tukey post hoc test was carried out to reveal between which groups the difference was.

Behavioural data was statistically analysed using a general linear model ANOVA with multiple comparisons to test for differences between the groups within each performed behaviour. A Tukey post hoc test was carried out to reveal between which groups the difference was.

The survival curves of TI duration and latency to first head movement, as well as TI inducibility, were statistically analysed using a Kaplan-Meier log-rank test. The survival plots for tonic immobility were done with Kaplan-Meier using MiniTab® 17 software (MiniTab Inc, State College, PA, USA).

The number of separate vocalisations, latency to vocalize, and type of vocalization during the 5 min recording was manually analysed using Adobe Audition CC 2015 software. This made it possible to not rely only on the sound, but being able to visually identify the call type using a sound spectrogram. A Kruskal-Wallis 1-way ANOVA with a Bonferroni comparison was conducted to test for differences in latency to first vocalization between the groups, as well as to test differences between each performed type of vocalization and finally, if there was any differences in total number of separate vocalizations.

A 1-way ANOVA was conducted to test for differences in number of birds present within a bird length of the novel object between the two strains of chicken (Rowan Ranger and Ross), and also between the two age groups of Rowan Rangers (5 and 8 weeks). A post-hoc Tukey test was carried out to reveal between which groups the difference was.

All data from the activity loggers were downloaded using MotionWare 8 software after which it was imported into Excel (Microsoft Office 2013) and made ready to analyse. A custom made program (LabView 2014, National Instruments Inc.) was then used to extract useful information, such as absolute time spent outside and percent mobile time. The program was set up to divide the recorded light- and activity data into periods of morning, afternoon and night time, according to the actual opening and closing of the chicken house gates, because of expected differences in activity throughout the day. There was a threshold set to the light data of 300 lux, so data points above the threshold accounted for as the individual being outside. The threshold of 300 lux was based on measurements done throughout several days by using a HI97500 Portable Lux Meter (Hanna© Instruments). The activity

data had a threshold of 20 bouts s^{-1} which based on pilot measurements could distinguish noise from proper activity. A general linear ANOVA with a Tukey comparison was conducted to test for differences in the light data received from the loggers as well as interactions between group and light. The activity data received from the loggers was analysed using a Kruskal-Wallis 1-way ANOVA with a Bonferroni comparison.

4 Results

4.1 Rowan Ranger chicken grow at similar rates as Ross 308

There was a statistically significant difference in body weight between the three groups of chickens ($F_{(2,89)} = 134.9$; $P \leq 0.0001$). As expected, Rowan Rangers at 5 weeks (1.33 ± 0.23 kg) weight significantly less than both Rowan Rangers at 8 weeks (2.29 ± 0.33 kg) and Ross 308 at 8 weeks (2.44 ± 0.31 kg). Rowan Rangers at 8 weeks and Ross 308 at 8 weeks did not differ significantly in weight (Figure 6), showing that Rowan Rangers and Ross 308 have similar weight at the same age (when Ross 308 are subjected to a qualitative feed restriction).

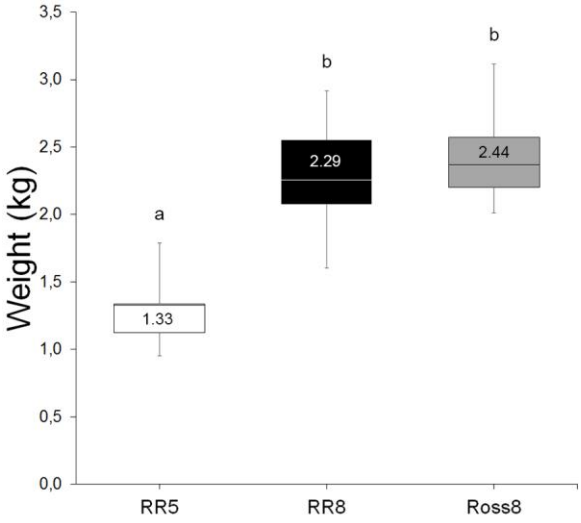

Figure 6. Box plot displaying that Rowan Rangers at 5 weeks of age has a significantly lower body weight than both Rowan Rangers and Ross 308 at 8 weeks of age. The box plot is shown with whiskers representing the maximum and minimum value. The numbers in the boxes is the average weight for each group. The letters indicate a significant difference. RR5 = Rowan Rangers 5 weeks (N = 36), RR8 = Rowan Rangers 8 weeks (N = 36) and Ross8 = Ross 308 8 weeks (N = 20).

4.2 Rowan Rangers spend more time lying down and perform less feeding behaviour than Ross 308

There is a significant difference between the test groups of chickens regarding time spent performing the tested behaviours in the ethogram (Table 1) ($F_{(18,287)} = 124.46$; $P \leq 0.0001$). Ross 308 at 8 weeks spent significantly more time performing feeding behaviour than Rowan Rangers at 8 weeks ($T = 9.23$; $P \leq 0.0001$) and significantly less time lying down compared to Rowan Rangers at 8 weeks ($T = -10.32$; $P \leq 0.0001$) (Figure 7).

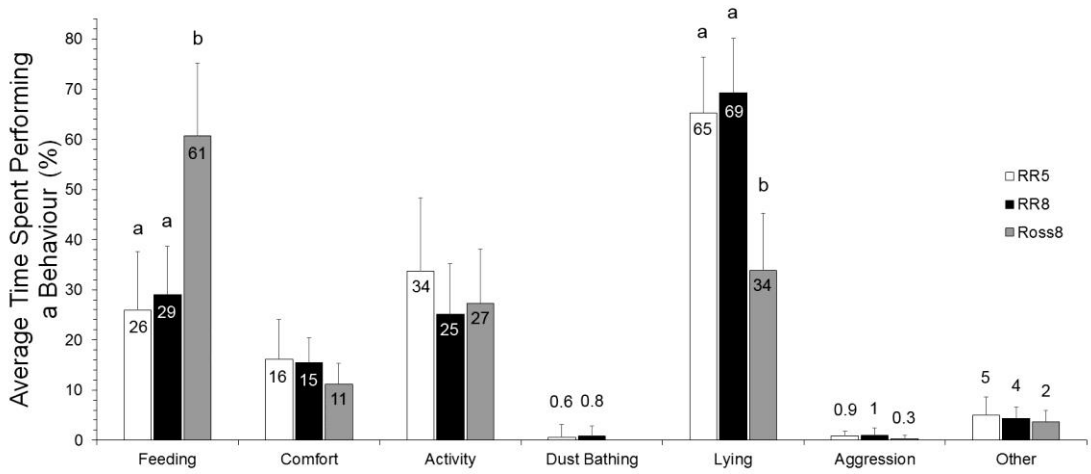

Figure 7. Bar chart displaying average time (%) spend performing a behaviour during the observed time for the three test groups of chickens. The bar chart is shown with whiskers (+1 SD). The numbers in the bars display average time (%) spent performing a behaviour and letters indicate a significance difference. RR5 = Rowan Rangers 5 weeks (N = 72), RR8 = Rowan Rangers 8 weeks (N = 72) and Ross8 = Ross 308 8 weeks (N = 32).

4.3 Rowan Rangers have a similar tonic immobility duration and latency to first head movement as Ross 308

After three consecutive tries, none of the three experimental groups of chickens had all individuals successfully induced into tonic immobility (Figure 8). When comparing the individuals successfully induced and those that were not in each test group, a significant difference was found between the three groups ($\chi^2_{(2)} = 11.1$; P = 0.004) and that is that Rowan Rangers at 5 weeks are more inducible than Ross 308 at 8 weeks ($\chi^2_{(1)} = 10.2$; P = 0.001).

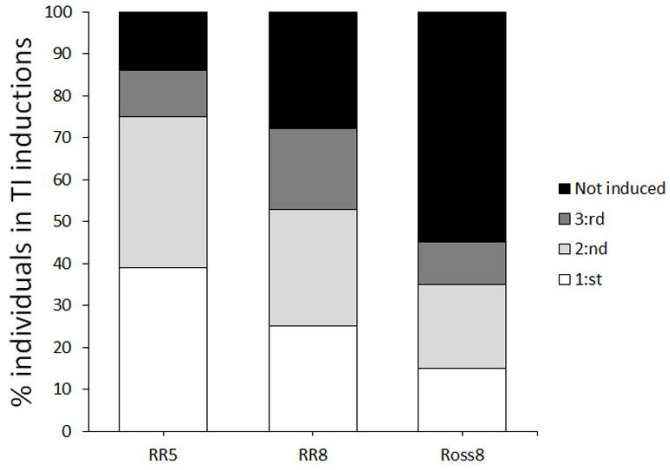

Figure 8. Bar chart showing the number of individuals (%) successfully induced after each of three induction trails, as well as those deemed unsusceptible to tonic immobility for the three experimental groups of chicken. There is a significant difference in inducibility between Rowan Rangers at 5 weeks of age and Ross 308 at 8 weeks of age. RR5 = Rowan Rangers 5 weeks (N = 36), RR8 = Rowan Rangers 8 weeks (N = 36) and Ross8 = Ross 308 8 weeks (N = 20).

Amongst those individuals that were successfully induced, no significant difference was detected in TI duration ($\chi^2_{(2)} = 3.95$; P = 0.139). Ross 308 at 8 weeks had on average a shorter duration (mean 160.9 ± 77.0 s) than both Rowan Rangers at 5 weeks (mean 190.8 ± 101.8 s) and Rowan Rangers at 8 weeks (mean 222.3 ± 91.9 s) as shown by the survival curves in Figure 9a.

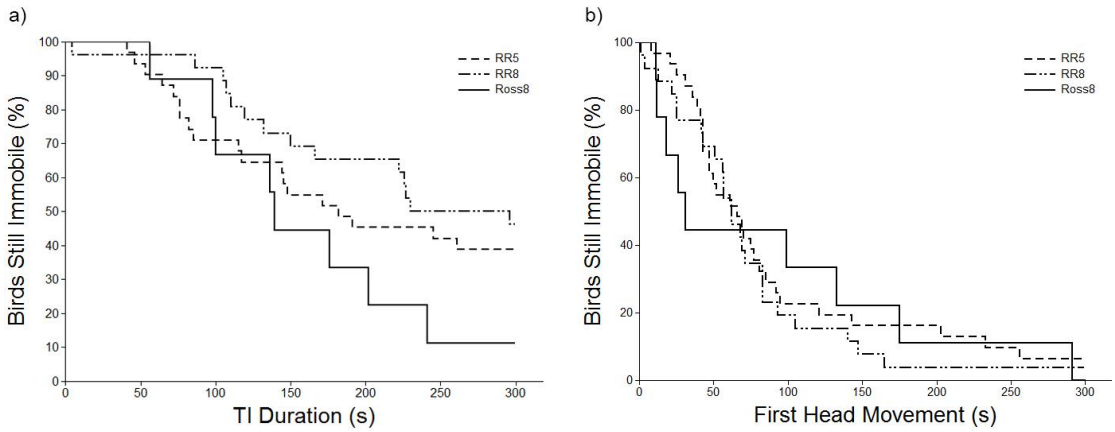

Figure 9 a) Survival curves for TI duration (s) for individuals successfully induced in all three experimental groups of chicken; RR5 (N = 31), RR8 (N = 26) and Ross8 (N = 9). b) Survival curves for latency to first head movement (s) for individuals successfully induced in all three experimental groups of chicken; RR5 = Rowan Rangers 5 weeks (N = 31), RR8 = Rowan Rangers 8 weeks (N = 26) and Ross8 = Ross 308 8 weeks (N = 9).

Amongst those individuals that were successfully induced, no significant difference was detected for latency to first head movement ($\chi^2_{(2)} = 0.44$; P = 0.804). Rowan Rangers at 8 weeks (mean 74.1 ± 61.9 s) had on average a shorter latency than Rowan Rangers at 5 weeks (mean 92.0 ± 80.8 s) and Ross 308 at 8 weeks (mean 88.4 ± 96.6 s), as shown in Figure 9b.

4.4 Rowan Rangers perform more fear trills than Ross 308 when socially isolated

There is no significant difference between the groups of chickens regarding latency to first vocalization ($H_{(2)} = 5.08$; P = 0.079) or total number of separate vocalizations ($H_{(2)} = 3.91$; P = 0.142). Ross 308 at 8 weeks had on average longer latency to vocalize (33.4 ± 61.09 s) than both Rowan Rangers at 8 weeks (23.2 ± 36.59 s) and Rowan Rangers at 5 weeks (5.95 ± 10.18 s). Rowan Rangers at 8 weeks had on average more separate vocalizations (30.6 ± 31.03) than both Rowan Rangers at 5 weeks (17.4 ± 19.32) and Ross 308 at 8 weeks (21.4 ± 29.73).

The test revealed no significant difference in the distribution of distress calls made between the groups ($H_{(2)} = 0.19$; P = 0.909), but there was however a significant difference between the distribution of fear trills made ($H_{(2)} = 11.61$, P = 0.003) and other calls made ($H_{(2)} = 8.15$; P = 0.017) between the groups (Figure 10). The average occurrence of distress calls was about the same for Rowan Rangers at 5 weeks (11.76 ± 14.73), Rowan Rangers at 8 weeks (17.29 ± 22.11) and for Ross 308 at 8 weeks (17.81 ± 28.56).

The test revealed a significant difference in the distribution of fear trills made between Rowan Rangers at 5 weeks and Rowan Rangers at 8 weeks ($Z = 4.15$; $P \leq 0.0001$) where Rowan Rangers at 5 weeks had on average less fear trills (0.18 ± 0.727) than Rowan Rangers at 8 weeks (5.2 ± 10.264) (Figure 10). The test also revealed a tendency for Rowan Rangers at 8 weeks (5.2 ± 10.264) making significantly more fear trills than Ross 308 at 8 weeks (0.75 ± 1.238) ($Z = 1.91$; $P = 0.056$) (Figure 10).

There was a significant difference between Rowan Rangers at 8 weeks and Ross 308 at 8 weeks regarding other calls made ($Z = 2.85$; $P = 0.0043$) where Rowan Rangers 8 weeks had on average more other calls (8.13 ± 10.4) than Ross 308 at 8 weeks (2.88 ± 3.7) (Figure 10).

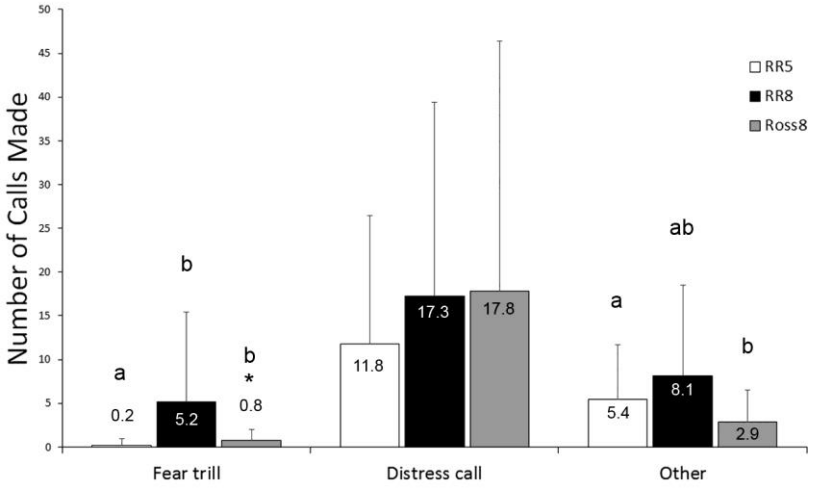

*Figure 10. Bar chart with whiskers (+1 SD) displaying the average number of calls made within each experimental group of chickens; RR5 = Rowan Rangers 5 weeks (N = 33), RR8 = Rowan Rangers 8 weeks (N = 31) and Ross8 = Ross 308 8 weeks (N = 16). Letters indicate a significance and * indicate a tendency.*

4.5 Rowan Rangers seems to be more curious of the Novel object than Ross 308

There were two measurements done in the same house and these were averaged which gave a total of 6 measurements for Rowan Rangers at 5 weeks and Rowan Rangers at 8 weeks, and 4 measurements for Ross 308 at 8 weeks. The following 5 variables were tested: (1) number of birds at 60 s, (2) number of birds at 120 s, (3) total number of birds in the first minute, (4) total number of birds in the second minute, and (5) total number of birds during the whole trial of two minutes.

There was a significance between the three test groups of chickens at 60 s (variable 1) ($F_{(2,13)} = 4.551$; P = 0.032) and the difference was between Rowan Rangers at 5 weeks and Ross 308 at 8 weeks (*P* = 0.029). There was no significant difference at 120 s (variable 2) ($F_{(2,13)} = 2.638$; P = 1.117) (Figure 11).

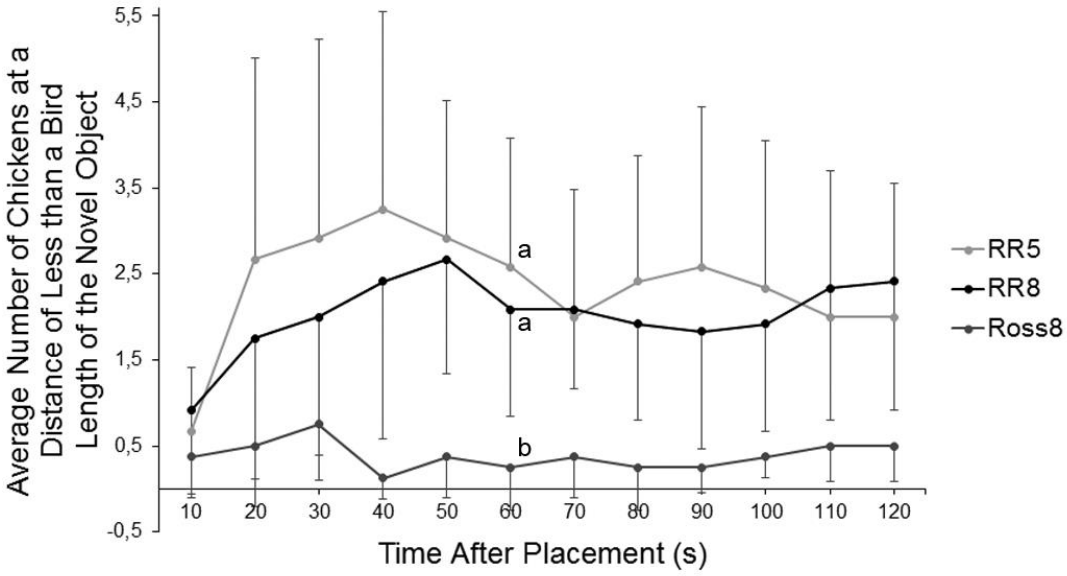

Figure 11. Graph with whiskers (±1 SD) displaying average number of birds at a distance less than a bird length of the novel object for all three experimental groups of chickens; RR5 = Rowan Rangers 5 weeks, RR8 = Rowan Rangers 8 weeks and Ross8 = Ross 308 8 weeks. Letters indicate a significant difference at a specific time point.

For variable 3-5 the test revealed tendencies for significant differences. Taking into account the number of birds present within a birds length of the novel object the whole first minute (variable 3), there is a tendency for a difference between the groups ($F_{(2,13)} = 2.999$; P = 0.085). The same goes for the whole second minute (variable 4) ($F_{(2,13)} = 3.408$; P = 0.065). If looking at both minutes as a whole (variable 5), there was also a tendency for a significant difference ($F_{(2,13)} = 3.245$; P = 0.072) where there was on average fewer Ross 308 at 8 weeks of age investigating the novel object (mean 4.6 ± 4.42) than there was Rowan Rangers at 5 weeks (mean 28.3 ± 19.17) or Rowan Rangers at 8 weeks (mean 24.3 ± 14.37).

4.6 Rowan Rangers spend as much time on the outside perimeter as Ross 308

4.6.1 Light data

There were no significant difference between the three test groups of chickens regarding how many visits they made to the outside perimeter per hour during the *morning* compared to the *afternoon* ($F_{(1,139)} = 2.03$; P = 0.156). Rowan Rangers at 8 weeks had on average more visits outside during the *morning* (mean 1.30 ± 1.05 visits/h) than both Rowan Rangers at 5 weeks (mean 1.25 ± 0.87 visits/h) and Ross 308 at 8 weeks (mean 0.71 ± 0.56 visits/h) (Figure 12a). Ross 308 at 8 weeks had on average more visits to the outside perimeter during the *afternoon* (mean 1.08 ± 0.72 visits/h) than both Rowan Rangers at 5 weeks (mean 0.71 ± 0.58 visits/h) and Rowan Rangers at 8 weeks (mean 0.85 ± 0.69 visits/h) (Figure 12a).

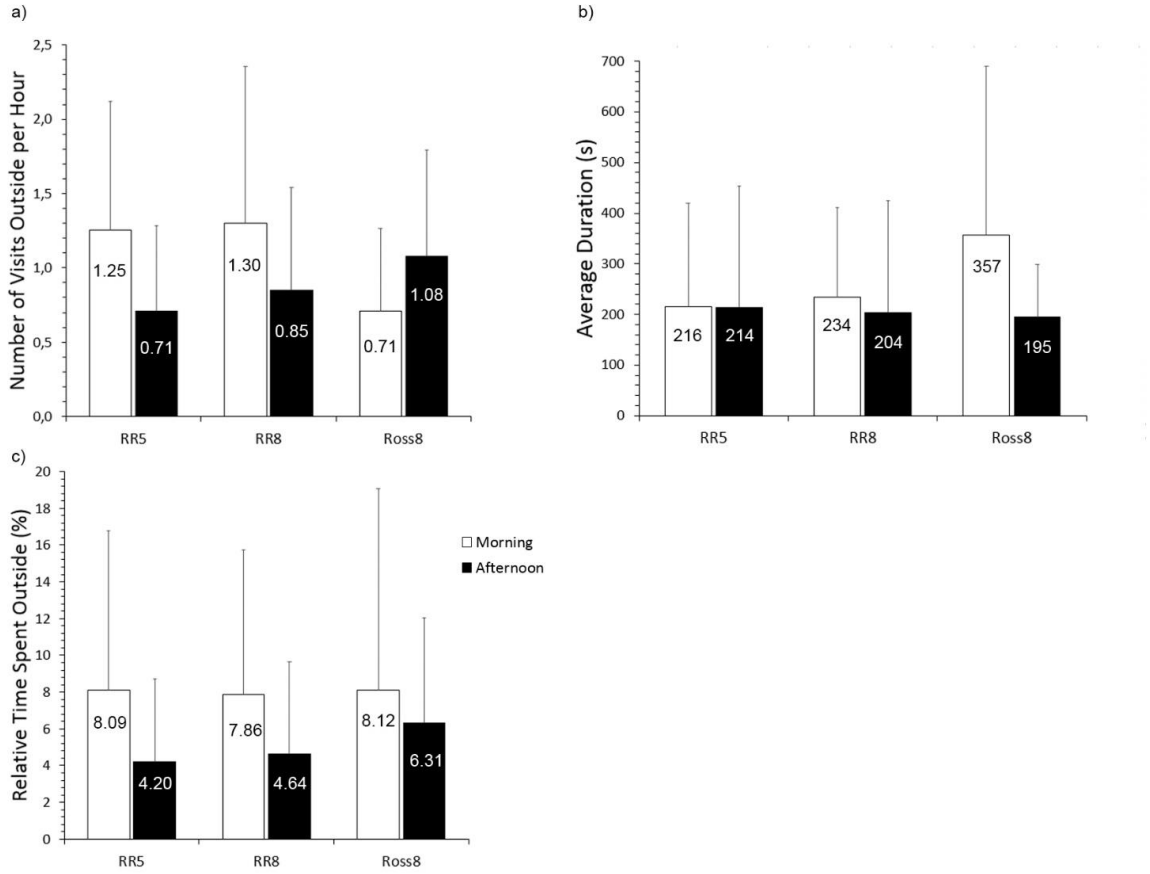

Figure 12. Bar chart with whiskers (+1 SD) of a) relative number of events displaying how often the chickens went outside during the morning and afternoon respectively, b) average duration (s) displaying how long the chickens spent outside during an event during the morning and afternoon respectively, and c) average relative events (%) displaying relative events for the morning and afternoon respectively. Numbers in the bars are averages.

RR5 = Rowan Rangers 5 weeks (N = 35), RR8 = Rowan Rangers 8 weeks (N = 36) and Ross8 = Ross 308 8 weeks (N = 17).

There was no significant difference regarding average duration spent outside whilst being on the outside perimeter ($F_{(1,138)} = 2.84$; $P = 0.094$) (Figure 12b). Ross 308 at 8 weeks had on average a longer duration outside during the *morning* (357 ± 332 s) than both Rowan Rangers at 5 weeks (216 ± 203 s) and Rowan Rangers at 8 weeks (234 ± 178 s) (Figure 12b).

There was a significant difference between the relative time (%) *all* animals spent outside during the *morning* compared to the *afternoon* ($F_{(1,139)} = 5.00$; $P = 0.027$) but there were no significant differences at group level ($F_{(2,139)} = 0.18$; $P = 0.840$). Ross 308 at 8 weeks had on average a higher percentage of relative time spent outside (8.12 ± 10.93 %) during the *morning* than both Rowan Rangers at 5 weeks (8.09 ± 8.69 %) and Rowan Rangers at 8 weeks (7.86 ± 7.86 %) (Figure 12c). Ross 308 at 8 weeks had also a higher percentage of relative time spent outside (6.31 ± 5.71 %) during the *afternoon* than both Rowan Rangers at 5 weeks (4.20 ± 4.52 %) and Rowan Rangers at 8 weeks (4.64 ± 5.00 %) (Figure 12c).

4.6.2 Activity data

There was a significant difference regarding active bouts per hour during the *morning* and during the *afternoon* between the three test groups of chickens. Rowan Rangers at 5 weeks had on average significantly more active bouts per hour (47.3 ± 5.22 active bouts/h) during the *morning* than Rowan Rangers at 8 weeks (41.7 ± 4.63 active bouts/h) (Figure 13a). Ross 308 at 8 weeks had on average significantly more active bouts per hour (52.6 ± 6.50 active bouts/h) during the afternoon than both Rowan Rangers at 5 weeks (43.0 ± 4.35 active bouts/h) and Rowan Rangers at 8 weeks (37.8 ± 5.43 active bouts/h) (Figure 13a). Rowan Rangers at 5 weeks had also on average significantly more active bouts per hour during the *morning* than in the *afternoon*, and Ross 308 at 8 weeks had on average significantly more active bouts per hour during the *afternoon* than in the *morning* (Figure 13a).

There was a significant difference in relative activity during the *morning* with Rowan Rangers at 5 weeks having a higher percentage relative activity (41.5 ± 7.83 %) than Rowan Rangers at 8 weeks (30.4 ± 5.67 %) (Figure 13b). Ross 308 at 8 weeks had a significantly higher percentage of relative activity (51.6 ± 9.22 %) during the *afternoon* than both Rowan

Rangers at 5 weeks (40.4 ± 6.74 %) and Rowan Rangers at 8 weeks (31.3 ± 7.44 %) (Figure 13b).

Rowan Rangers at 5 weeks had on average a significantly longer duration of activity (32.0 ± 6.72 s) during the *morning* than Rowan Rangers at 8 weeks (26.3 ± 4.46 s) (Figure 13c). Ross 308 at 8 weeks had on average a significantly longer duration of activity (35.5 ± 6.82 s) during the *afternoon* than both Rowan Rangers at 5 weeks (32.2 ± 6.50 s) and Rowan Rangers at 8 weeks (30.7 ± 9.84 s) (Figure 13c).

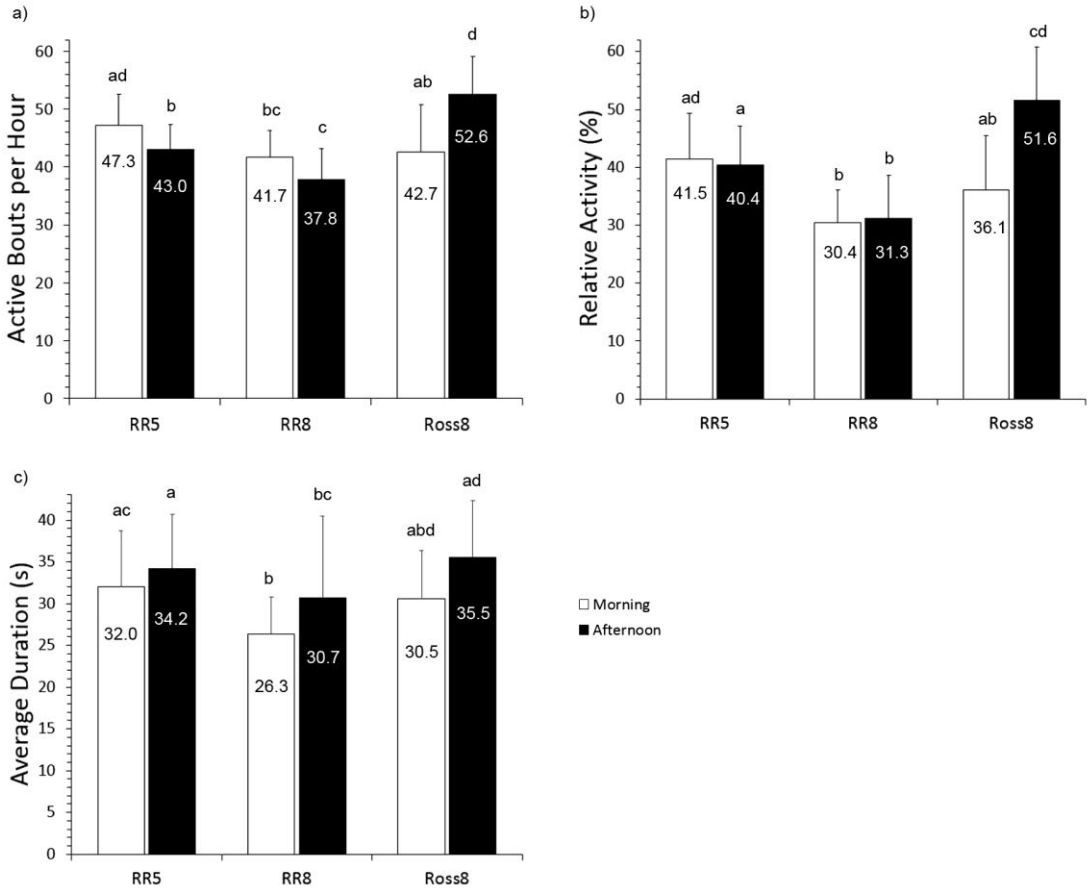

Figure 13. Bar chart with whiskers (+1 SD) of a) active bouts per hour displaying how often the activity count was over the threshold during the morning and afternoon respectively, b) relative activity (%) displaying average time the chickens moved during daylight hours for the morning and afternoon respectively, and c) duration (s) displaying average duration of activity. Numbers in the bars are averages and letters indicate a significance. RR5 = Rowan Rangers 5 weeks (N = 35), RR8 = Rowan Rangers 8 weeks (N = 31) and Ross8 = Ross 308 8 weeks (N = 12).

5 Discussion

In this study, I compared differences between a naturally slow growing strain of chicken to a fast growing strain to investigate whether there were differences in behaviour between the two, if one of the strains were more susceptive to stress than the other and whether they differed in outdoor use and activity level.

Among the chickens' that got to wear the loggers, all groups, regardless of strain, used the outdoor perimeter the same amount of time with no significant differences. This finding was interesting since the farm owners expressed concern that the Rowan Rangers did not seem to use the outdoor perimeter as much as Ross 308.

A well-known problem in free-range broiler production is that even though they have access to an outdoor perimeter, they don't necessarily go outside at all, or if they go outside they stay close to the chicken house walls (Dawkins et al. 2003; Rodriguez-Aurrekoetxea et al. 2014; Sossidou et al. 2011), something that was also observed in this study concerning the Rowan Rangers. Possible explanations for why chickens do not go out to the outside perimeter could be that (i) there is little motivation to go out since the chickens' basic requirements are already met in the chicken house (Zeltner & Hurt 2003), (ii) the fear of predators and for the surroundings are keeping the chickens inside (Sossidou et al. 2011), and (iii) the weather is too cold or wet (Gilani et al. 2014).

An observation made during the data collection was that the Rowan Rangers seem to be outside as much as the Ross 308 but they kept closer to the chicken house and did not wander off and spread as much as the Ross 308. One explanation to this could be that the chicken houses were all placed on a flat, open grass area and it could be that the Rowan Rangers have a higher innate fear to predators and would prefer an outdoor area with more bushes and hiding places as protection from the circling birds of prey (e. g. Red Kites). Planting bushes, trees and higher grass might make the Rowan Rangers spread further from the house.

A previous study by Rodriguez-Aurrekoetxea et al. (2014) on a strain of slow growing chicken found that far from all individuals actually used the outdoor area and that increased environmental complexity outdoors had no effect on the outdoor use. However, they argue that based on their results, a larger number of enrichments outside is needed than that of what they used, to provoke a greater interest in the outdoor perimeter (Rodriguez-Aurrekoetxea et al. 2014). Rodriguez-Aurrekoetxea et al. (2014) instead argues that the effect of the outdoor usage varied with age and temperature, with more usage of the outdoor areas in

warmer temperatures and with increasing age. Other studies contradict the fact that enrichment outside has no effect of the outdoor usage. Dawkins et al. (2003) found positive effects of cover, such as bushes and other vegetation, on the percentage of range use, and Gilani et al. (2014) found that more natural and artificial cover helped draw the chickens outside and away from the house. Other studies do agree that weather plays a role in the outdoor use. The percentage of outdoor use decreased during wet weather (Gilani et al. 2014) and increased during warmer weather conditions (Dawkins et al. 2003). Perhaps chickens' will go outside and range further even during wet and colder weather if shelter is provided? Dawkins et al. (2003) also showed an increased use of the outdoors during the afternoon and evening, something this study found to be true for Ross 308.

One disadvantage of ranging too far is a higher risk of being attack by predators but on the other hand, staying close to the house will increase flock density and parasitic diseases are very common at those places (Sossidou et al. 2011).

Although there might be a problem to attract chickens to the outside perimeter, there are studies showing that slow growing broilers are generally more active than fast growing broilers, such in a study by Bokkers & Koene (2003). Moreover, the same study show that slow growing broilers spend more time walking, while fast growing broilers spend more time sitting on the floor, eating and drinking, when comparing slow growing broilers to fast growing broilers.

That is somewhat in line with what this study found, which was that Rowan Rangers perform less feeding behaviour than Ross 308. However, this study found that Ross 308 spend more time walking (being active) than Rowan Rangers, which contradicts previous findings by Bokkers & Koene (2003). This might be supported by the hypothesis that the Ross 308 is constantly hungry and in search of food most of the waking hours.

Being qualitative feed restricted results in hunger and an increased motivation for food, expressed as an increased activity and foraging behaviour (D'eath et al. 2009; Eriksson et al. 2010). Although the fast growing strain Ross 308 get fed *ad libitum* in organic production, they are qualitative feed restricted (given a diet of low protein) and it might be that they never feel satiated. This could be supported by the fact that Ross 308 had on average significantly more active bouts and a higher percentage of relative activity during the afternoon than both age groups of Rowan Ranges. Is it perhaps the case that the Ross 308 are hungrier during the afternoon and therefore intensify their food search by having

higher activity during the afternoon than Rowan Rangers at the same age, as indicated by the results?

As mentioned earlier, one explanation for chickens' not to go outside is a fear of predators and a fear of open spaces (Sossidou et al. 2011). Although fear is associated with stress, stress can also be linked to high litter moisture and air ammonia (Dawkins et al. 2004). The failure to cope with an aversive situation, such as high stocking density and poor environmental situations, results in stress. Fear can be measured by the duration of tonic immobility, which is an innate state of paralysis in chickens and is a well-studied phenomenon (Wang et al. 2013). The longer the duration of tonic immobility, the higher level of fearfulness and the higher risk of chronic stress (Wang et al. 2013). Long durations of tonic immobility have been shown to affect growth performance and behaviour negatively, where individuals with long durations of tonic immobility grow slower and shows less positive behaviours, such as preening, compared to individuals with short durations of tonic immobility (Wang et al. 2013).

There was a tendency for the younger group of Rowan Ranger to be more inducible to tonic immobility than the older group of Rowan Ranger, and also a tendency for the older group of Rowan Ranger to be more inducible than Ross 308. Amongst those individuals that were successfully induced, Ross 308 had a shorter tonic immobility duration than both age groups of Rowan Rangers. Although the result was not statistically significant, this finding might indicate that the naturally slow growing Rowan Ranger has a higher level of fear than the fast growing Ross 308. This difference in fear does not seem to hinder the Rowan Rangers, who seem to grow at a similar rate as the Ross 308 (although Ross 308 is qualitative feed restricted). Also, there does not seem to be any difference in performing positive behaviour (comfort behaviours in this study). In fact, Rowan Rangers even show on average more interest of the novel object than Ross 308, indicating a positive emotional state (Welfare Quality® 2009).

Andrew (1964) argued that the calls of the chicken are provoked by stimuli, that the calls form a single system that differ in intensity and persistence by increasing the number trill cycles, pitch and length. Therefore one can often identify a call by the situation in which it is given, although one must keep in mind that the same call can be given under a number of situations (Collias 1987). Chickens are generally said to be social animals and they use their wide repertoire of vocalizations as a social tool (Marx et al. 2001). When isolated from the group, the chick

normally tries to reinstate contact with their conspecifics by using their vocal repertoire to call for assistance, especially by using distress vocalization (Collias 1987; Marx et al. 2001). Whilst distress calls are usually vocally expressed during social isolation, fear trills are often expressed anticipating danger, or when the chick is suddenly handled (Marx et al. 2001).

The vocal repertoire can be used as a tool to detect situations that are stressful to the chick (Marx et al. 2001), which one can assume that social isolation is, and ultimately one can assess the chicks' well-being (detect poor welfare) by studying and analysing the chicks' vocal repertoire. The two main sound signals the domestic fowl gives, as well as for many other species of birds, are the distress calls and the pleasure notes, and these sounds reflect the security-insecurity balance that controls the behaviour of the chick in general (Collias & Joos 1953).

The older group of Rowan Rangers made as many distress calls as Ross 308 at the same age but made significantly more fear trills and other calls. The chick can sometimes give a fear trill when handled (Collias & Joos 1953) so it may be that the chick gave fear notes shortly after being put in the cardboard box. Some individuals did however give fear trills during the whole isolation period of 5 min, again, indicating that the Rowan Ranger might have a higher level of fear then Ross 308. This goes hand in hand with the thought that the Rowan Rangers might have a more innate fear of predators than Ross 308 and therefore stay closer to the chicken house whilst being on the outdoor perimeter. As argued earlier, this is something that has both pros and cons. A positive aspect is that the chickens might stay clear of predators, but at the same time the risk of parasitic diseases might increase.

Just by looking at the graph for the novel object test one could make the assumption that the Rowan Ranger have a more positive emotional state than Ross 308, as the assessment protocol for poultry states that the outcome of the test will show. However, the variation in the novel object test is too large to make any conclusions and therefore the statistical analysis shows no differences between the strains. One should also keep in mind that it is difficult to say that the Rowan Rangers are in a more positive state of mind since animals' emotions are hard to assess. It might be close at hand to say that the Rowan Rangers seem more curious than Ross 308 since there were on average more Rowan Rangers around investigating the novel object. Curiosity is not an emotion though, but a personality trait. This study took place on a farm and thus limited the type of test doable during the experimental period. To thoroughly test

emotions and personality you need to move the animals to a more controlled clinical setting and perform a broader variety of tests.

In addition, an observation made during the data collection at Bosarp Farm is that the Rowan Rangers all had a nice feather coat and whilst being on the farm, no feather pecking amongst the Rowan Rangers was observed (they were even observed preening each other). As for Ross 308, many of the individuals were feather pecked on their back and a higher occurrence of aggressive behaviour was spotted amongst the flocks. This higher occurrence of aggressiveness was not observed during the behavioural study and not corroborated by the data presented earlier. A possible explanation to this could be that during the behavioural study the fenced off area with the focal animals had a lower stocking density than otherwise experienced in the house. It could be that the animals fenced in were part of a sub-group formed in the larger flock and that the chickens were familiar to each other and already had an established dominance order. However, this study did not discriminate between females and males and it is plausible that there are differences in aggression level amongst sexes and that the fenced in animals just happened to have lower aggression levels than others roaming in the chicken house. This is something that future studies can focus on together with studies on foot- and leg problems, gait and mortality, in further assessing the use of Rowan Rangers versus Ross 308 in organic chicken meat production.

5.1 Conclusions

Although this study found that the slow growing strain Rowan Ranger are similar to the fast growing strain Ross 308, there are a few key points where they differ. It seems that the Rowan Ranger have a higher innate fear than Ross 308, keeping them from spreading out on the outside perimeter. Even so, they seem to be more suitable in an organic setting than Ross 308 due to the fact that they seem less hungry and more content, this based on the fact that they perform less feeding behaviour and spend more time laying down. Also, they grow nicely to slaughter weight with a good diet quality whereas Ross 308 need to be qualitative feed restricted to do the same, giving the Rowan Rangers better welfare.

5.2 Societal and ethical considerations

The need for a natural slow growing strain of broiler chicken is long overdue. Keeping fast growing broiler hybrids in organic production

might compromise animal welfare. This study aims to enhance the understanding of the behaviour of the natural slow growing Rowan Ranger and it might also provide a basis for further studies in this field. This study worked with chickens *in situ* and although the handling and some of the tests might have been stressful for the chickens, none of the chickens were injured or hurt in any way.

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