

RESEARCH REPORT: PASTURED LIVESTOCK 2016

Pasture-raised chicken comparison

Summary

- The Nova Free Ranger, a new meat chicken from Nova Scotia bred for free range living, may better integrate into ecological farms and produce nutritionally-superior meat compared to the industrial White Rock – Cornish Cross.
- Given the fast growth rates of White Rocks, however, Nova Free Rangers may not be as profitable if they take longer to size up.
- Jason Hayes and Drake Larsen raised groups of Nova Free Ranger and White Rock chickens on pasture and measured feed intake, carcass yield, taste and nutritional quality.

Key findings

- From one successful replicate, the Nova Free Ranger group had a lower (better) average feed conversion ratio and greater return to labour (\$5.30/kg vs. \$5.05/kg).
- Blind taste tests suggest the taste and texture of Nova Free Ranger meat is preferred by culinary professionals but that the average non-chef customer may prefer the smoother texture of White Rock meat.
- Average OMEGA 6:3 ratio of one White Rock and one Nova Free Ranger was 9.5:1, higher (worse) than previously published results from pasture-raised chickens but lower (better) than previously published results from non-pasture-raised chickens. Vitamin content was higher than all previously published results.
- Delayed arrival of Nova Free Ranger chicks allowed analysis of only one replicate in 2016, **so additional replicates are needed to draw conclusions.**
- Evaluating the nutritional quality and profitability of alternative breeds on pasture helps producers choose breeds that are better suited to integrated, pasture-based farming.



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Funding:

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About the Farmers

Jason Hayes farms 30 acres at Burdock Grove near Williamsford with his wife, Marcelina Salazar. They raise chicken, duck, lamb, and pork in rotation on pasture and also grow vegetables.

Drake Larsen farms 50 acres at Three Ridges Ecological Farm near Aylmer with his wife, Sarah Hargreaves. They rotationally graze chicken, duck, pigs and a small cattle herd while establishing a diverse fruit and nut orchard.

Background

Pasture-raised chicken - chicken that is raised outside on grasslands - is an enterprise on many small and mid-scale integrated, ecological farms. Outdoor living results in added fertility in the form of manure for the pastures and quality of life for the animal. From a consumer perspective, rearing chickens on pasture can also produce meat rich in minerals, vitamins, amino acids and collagen as a result of sunlight, natural forage and insects. Two studies by the American Pastured Poultry Producers Association (APPPA) (1,2) show that, compared to USDA reference values for conventional chicken (3), pasture-raised chicken has lower OMEGA 6:3 ratios, saturated fat content and higher concentrations of vitamin E.

While this previous research shows that diet affects nutritional composition when conventional and pasture-raised chicken is compared, less is known about the performance, nutrition and taste of different breeds on pasture. Data from the APPA (2) showed (un-replicated) variation among different chicken breeds, suggesting there may be differences. To our knowledge, however, no studies have rigorously compared different breeds.

Research Question

New to Canada, the Nova Free Ranger (4) is a chicken bred for living on pasture from a diverse assortment of Heritage varieties. For this reason, it is garnering interest among pasture-based chicken farmers but it is still unclear how the Nova Free Ranger compares to the standard industrial White Rock – Cornish Cross in a production setting. The relatively small scale, labour intensive nature of pasture-based farming make margins tight and the low feed conversion ratio of the industrial White Rock, therefore, economically hard to replace.

With these considerations in mind, Jason Hayes and Drake Larsen asked the following question:

Does the Nova Free Ranger differ from the industrial White Rock with respect to feed intake, production cost, nutritional quality, and taste?

Prediction: Because they forage more on pasture, Nova Free Ranger chickens will have greater nutritional value but poorer feed conversion ratios and return to labour.

Methods

Jason Hayes and Drake Larsen, pasture-based livestock farmers in southwestern Ontario, conducted this research in summer 2016. The trial was designed for one replicate on Jason's farm and two replicates on Drake's farm. However, Drake's Nova Free Ranger chicks were delayed by 3 weeks so his comparison is not valid. Methods, therefore, focus on Jason's replicate but taste tests are from an off-set comparison raised by Drake and butchered on the same day (WR, 73 days; NFR 92 days).

Jason Hayes, Burdock Grove

Jason picked-up 150 White Rock (WR) day-old *pullets* from Frey's Hatchery on July 6 and 150 Nova Free Ranger (NFR) day-old *mix sexed* chicks from Nova Free Ranger Hatchery via airfreight from Halifax, Nova Scotia to Pearson International Airport on July 7. In the first week, NFR chicks experienced pasted vent, presumably from the stress of air travel. Jason typically orders WR pullets in order to have more consistent growth, and was only able to get mixed chick NFRs. Jason had both groups butchered at Scheffer Poultry Processing, Gorrie, ON, on

the morning of Sept. 12, after he withheld food starting at noon on Sept. 11. All dates are listed in Table 1.

Jason brooded the two groups of chicks in adjacent brooders in his barn, each with the same quantity and strength of brooder lamps, free access to water at all times and free choice access to Five Star 20% chick starter (ingredients list to follow). Jason switched both groups to Five Star 16% grower ration on July 26 (ingredients list to follow). Both groups were moved to pasture on July 30 (Table 1.), where Jason housed them in adjacent pens ("chicken tractors") each with a day range on open pasture enclosed by electro-netting (approx. 200 m²). On pasture, both groups always had access to clean water, and free choice feed. Shelters were moved daily and netting weekly at first, sliding to every four days at the end of the crop cycle. The pasture species were orchard grass 80%, weeds (knapweed, Queen Anne's lace) 10%, other grasses 2%, alfalfa 2%, clover 2%, vetch 2%, tall fescue 1% and timothy 1%. Jason recorded dates, mortalities, observations, and amount of feed consumed; Scheffer Poultry Processing gave Jason average weights from each group. From this data, we calculated feed conversion ratios (FCR) as total feed consumed (kg) / total meat (kg), where total meat is average carcass yield (kg) * number of chickens butchered. Jason also recorded fixed costs associated with raising the two groups: chick costs, time and gas for pick-up, feed costs, butchering costs. From these numbers, we calculated total cost per kg and return to labour was estimated from potential revenue generated.

Jason froze one Nova Free Ranger and one White Rock for nutritional analysis on September 12. On November 23 he delivered samples to Merieux Nutrisciences, Markham, ON for the following analyses: Fat by GC including CLA and OMEGA 6:3, Vitamin A, Vitamin E and Vitamin D.

Drake Larsen, Three Ridges Ecological Farm

On August 27, Drake had a cohort of mixed White Rocks butchered at 73 days and a cohort of mixed Nova Free Rangers butchered at 92 days at Chicken Little Poultry Processing, Aylmer, ON. Drake gave two chefs one NFR and one WR, both fresh and whole with giblets, and randomly labeled "A" (NFR) and "B" (WR) from a coin toss.

Chef 1 cooked the boneless skinless breast and then roasted the remaining parts to showcase texture differences. Chef 2 roasted both chickens whole with lemon (A wedges; B slices) for the same length of time. Chef 2 then served the birds to a group of 8 and had everyone rate both birds on colour, aroma, taste and texture using a scale of 1 (low) – 10 (best ever). Ratings were compared using a two-tailed t-test.

For additional experimental details, including a diagram of the experimental design, refer to the Research Protocol: efao.ca/research-library.

Results & Discussion

Feed consumption and conversion ratios

Overall, Nova Free Ranger group ate less than White Rock group. The NFR mixed chicks consumed 37.5 kg less chick starter and 25 kg less grower than the WR pullet chicks (Table 2). Air transportation may have played a role in the reduced intake of starter in the Nova Free Rangers, especially since many of the NFR chicks experienced pasted vent – a sign of stress

such as temperature fluctuations during air transport. Jason did not manage the pasted vent and Nova Free Rangers experienced fewer chick mortalities than the White Rock group (Table 3). The NFR group experienced more adult mortalities from euthanasia due to leg problems. Leg problems from fast weight gain are common in WRs but surprising in the NFRs.

At ~ 9.5 weeks, mean carcass yield was 2.28 kg (5.03 lb) for NFR pullets and 2.1 kg (4.63 lb) for WR mixed chicks. Despite the fact that fewer NFRs were butchered, these yields resulted in lower (better) feed conversion ratios for the NFR. NFR mixed sex group had an average feed conversion ratio of 2.43 compared to 2.73 for the WR pullet group (Table 3).

Not surprising, perhaps, Jason's feed conversion ratios are higher (worse) than the ideal ratios reported from the hatcheries. The Nova Free Ranger website (4) reports a FCR of 2.24 at 9 weeks and the Frey's Hatchery website (5) reports a FCR of 2.10 and 2.21 for cockerels at 8 and 9 weeks, respectively, and 2.34 for pullets at 8 weeks. This is likely because reported feed conversion rates are measured in more controlled environments (i.e. broiler barns) or represent the best rate possible.

All this said, this experiment is only one replicate so we are unable to assign a probability to Jason's data: **without additional replicates, we are unable to say whether Nova Free Rangers will always have lower feed conversion ratios than White Rocks.**

We are also unable to say whether the observed differences are due to the breed or differences in feed conversion between pullets and cockerels. Nonetheless, the data Jason collected for this first replicate is intriguing because it suggests that Nova Free Rangers may have feed conversion ratios that are better than, or at least comparable to, White Rocks when raised on pasture. "Back of the envelope calculations" suggest that feed conversion ratio for mixed WRs would have been only 2.59.

From Frey's website, we can estimate a FCR of 2.46 for WR pullets at 9 weeks $[(FCR_{WR_{cockerels, 9 wks}} * FCR_{WR_{pullets 8 wks}}) / FCR_{WR_{cockerels, 8 ks}} = (2.21 * 2.34) / 2.10 = 2.46]$, and then assume a FCR of mixed WR at 9 weeks is 2.34 or the average of pullets (2.46) and cockerels (2.21).

We can then use the FCR of Jason's WR pullets to estimate a FCR if the WRs were mixed sex. Estimated $FCR_{WR_{mixed}} = (Frey's FCR_{WR_{mixed}} * Jason's FCR_{WR_{pullet}}) / Frey's FCR_{WR_{pullet}} = (2.34 * 2.73) / 2.46 = 2.59$.

These preliminary results are contrary to what we predicted – that White Rock group should have better feed conversion ratios even on pasture. Interestingly Jason noted that the WRs were seen foraging on pasture more than the NFRs, and that the NFRs were much faster runners. If the superior feed conversion ratio of the Nova Free Ranger on pasture holds up in future replicates, Jason's notes suggest it may be due to activity levels. Perhaps the Nova Free Rangers are more efficient foragers and/or the coveted White Rock feed conversion ratio is not valid in a pasture-based operation, etc.

Nutritional analysis

A frozen sample of a White Rock and Nova Free Ranger was delivered to Merieux NutriSciences in Markham, Ontario. Both birds were cooked as per the instructions: for a 1.5 kg

bird, roast uncovered in a 350°F oven for approximately 1 hr 40 min or until an internal temperature of 180°F (82°C) is reached. Meat from a representative sample of the entire bird (meat and fat) was analyzed for various fats and vitamins, conjugated linoleic acid.

The results presented here are reference points and provide hints as to what drives nutritional quality in pasture-raised chicken, but we were unable to draw conclusions without replicated trials and replicated nutritional analyses (Table 4). The average OMEGA 6:3 ratio of Jason's Nova Free Ranger and White Rock chicken was 9.5:1, which is higher (worse) than the APPPA mean of 5:1 for pasture-raised chicken and lower (better) than previously published results from non-pasture-raised chicken (~14:1) (Table 4). A ratio of 1:1 is ideal, so the lower the ratio the better. OMEGA 6:3 measurements, however, are highly variable. For example, 4 non-pastured chicken sampled by the APPPA reported values ranging from 11:1 for free range non-organic and free-range organic to 23:1 for conventional whole chicken.

What is causing this variation? It is unknown, but the APPPA study suggests that feed - specifically soy content rather than practices such as "free range" and "organic" - may be a determinant affecting OMEGA 6:3 ratios. Soy-free chickens averaged a ratio of 3:1 and soy-fed chickens averaged a ratio of 8:1 (1). Soy's disruption of the OMEGA 6:3 ratio and may have played a role in the relative high OMEGA 6:3 ratio of Jason's chickens since his feed source was 24% soy. If one goal of pasture-based farming is to raise nutritionally-dense foods, these data suggest that soy content in feed should be tested with many (n=4 or more) replicate nutritional analyses.

Vitamin content of pasture-raised birds is also thought to be higher in pasture-raised chickens because of the exposure to sunlight and a varied diet from foraging on pasture. For example, Jason's chickens had vitamin D levels exceeding 75 IU/100mg and pasture-raised birds in the APPPA study had over 17 IU/100 mg, while non-pastured chicken from the APPPA study had less than 2 IU/100 mg (Table 4). Similarly, Vitamin E levels were above 1.75 IU/100mg in the pasture-raised birds compared in this study (Jason's and APPPA), while the APPPA non-pastured samples and the USDA reference had less than 1 IU/100mg (Table 4).

Taste test

From the blind taste test on a 9 week old White Rock and 13 week old Nova Free Ranger, both chefs were able to distinguish between the chickens, and both said they preferred the NFR. For Chef 1, the piecing stage revealed obvious difference in structure of the meat, with the NFR having a longer, flatter breast (Figure X). Chef 1 noted

"the flavor was the second difference: while the [WR] tasted like chicken, the [NFR] was more reminiscent of its poultry cousins duck, or game hen."

Chef 2 also preferred the Nova Free Ranger. The tasting group, however, was less decisive. Average ratings in all categories for both chickens were all high. Average ratings for colour, aroma and taste were all statistically indistinguishable, but the White Rock ranked significantly higher in the texture category (4% chance the difference detected is due to chance).

This result highlights an observation from Chef 1:

"The texture of the cooked meat was the first noticeable difference between the two – the Nova breast was more firm and had a little more chew to it – but in a pleasant way, like you might be eating a tender cut of beef. The White [Rock] breast was more like

what I think of as a (high quality!) supermarket chicken – the breast and legs were thick, and looked lovely. The texture of the breast broke down quickly in the mouth.”

While texture differences may also be due to the age difference between the birds (9 vs. 13 weeks), structural differences in the carcass suggest they may exist in part due to tissue composition and not age. Overall, these results suggest that culinary differences between the NFR and WR are subtle but noticeable to the trained eye and palate, and that non-chef customers may prefer the smooth texture of the pasture-raised White Rock over the “chewier” Nova Free Ranger.

Cost of production

Jason also recorded the fixed costs associated with each group (Table 5). Despite the fact that NFR chick cost, including gas and time to pick-up, was almost double that for WRs, NFR's had a return to labour of \$1,656.29 or \$5.30/kg (\$2.40/lb) compared to \$1,515.29 or \$5.05/kg (\$2.29/lb) for WRs. This is because of the greater total weight of the NFR combined lower butchering cost due to less shrink wrap used on smaller pieced breasts and \$0.25/lb higher price-point.

For his comparison, Jason considered labour costs beyond chick pick-up equal. Another consideration is labour costs. While Jason's grow-out period for both breeds was the same, many US growers take their “heritage derived” “free range” broilers (i.e. “Freedom Ranger” and “Red Rangers”) to 10-12 weeks. While not rigorously comparable, Drake observed that Nova Free Rangers grew more slowly than his White Rocks - a discrepancy that would be teased apart with more replicates. Finally, labour for chicks experiencing pasted vent can be non-trivial, and should be tracked in future trials.

Next Steps

Based on the results from this first replicate, the Nova Free Ranger group had lower (better) average feed conversion ratios, greater return to labour, and a more sophisticated taste albeit chewier texture than the White Rock group; the average nutritional profile from the Nova Free Ranger and White Rock was better than reference values from non-pastured chicken.

These data represent only one replicate, however, such that **we are unable to say whether Nova Free Rangers have lower feed conversion ratio and tastier meat than White Rocks or a different nutritional profile than White Rocks or non-pastured chicken.** Future replicate studies are needed to assign certainty to these results. To do this, future replicates may want to include 1) step and peck rates to estimate foraging ability and energy spent foraging, 2) comparison in more confined “chicken tractors” without a range on open pasture, 3) additional comparison to Bonnie's Heavy Red as a “free range friendly” broiler without the airfreight costs.

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IMAGES AND TABLES ON NEXT PAGE

Image 1. Nova Free Rangers on pasture.



Image 2. Boneless skinless breast of a Nova Free Ranger (left) and White Rock (right) chicken. Photo credit: Ellen Laing.



Table 1. Management dates for chickens raised at Burdock Grove

DATES	Nova Free Ranger	White Rock
Arrival of day-old chicks	July 7, 2016	July 6, 2016
Age when switched to grower (July 26, 2016)	19 days or 2 weeks, 5 days	20 days or 2 weeks, 6 days
Age when moved to pasture (July 30, 2016)	23 days or 3 weeks 2 days	24 days or 3 weeks 3 days
Age at time of butcher (September 12, 2016)*	67 days or 9 weeks 4 days	68 days or 9 weeks 5 days

* food withheld at noon on September 11, 2016

Table 2. Chicken feed consumption and conversion ratios for Burdock Grove

FEED CONSUMPTION	Nova Free Ranger	White Rock
20% starter consumed (kg)	81.25	118.75
16% grower consumed (kg)	675	700
Total feed consumed (kg)	756.25	818.75
Total weight (kg)	312.6 (689.11 lb)	300.3 (662.09 lb)
Average carcass yield (kg)	2.28 (5.03 lb)	2.1 (4.63 lb)
Average total meat (kg)	312.36	300.3
Average feed conversion efficiency	2.42 - mixed	2.73 - pullets
Adjusted "guesstimate" for mixed		2.59

Table 3. Cohort statistics for chickens raised at Burdock Grove

STATISTICS	Nova Free Ranger	White Rock
Day-old chicks picked up	150 - mixed	150 - pullets
Mortalities at day 10	2	4
Additional mortalities	9*	3
Total mortality rate		
Butchered	137	143
Condemned	1 (inadequate bleed)	

Table 4. Nutritional analysis of one Nova Free Ranger and one White Rock chicken raised pasture at Burdock Grove compared to values published by the American Pastured Poultry Producers Association (APPPA), the USDA and the Chicken Farmers of Canada (CFC).

Measurement	Unit	NFR	WR	Mean	APPPA-pastured	APPPA-non-pastured	USDA	CFC
Total Fat as Triglycerides by GC	g/100g	21.57	9.81	15.69				14.53
Saturated Fatty Acids	g/100g	6.01	2.45	4.23	1.28		2.66	4.15
cis-Monounsaturated Fatty Acids	g/100g	9.49	3.23	6.36	1.78		3.82	6.35
cis-Polyunsaturated Fatty Acids	g/100g	5.02	3.65	4.335	1.34		1.96	2.82
Omega-6 Fatty Acids	g/100g	4.58	3.27	3.925	1.167		1.74	2.58
Omega-3 Fatty Acids	g/100g	0.44	0.38	0.41	0.229		0.12	0.18
6:3		10.41	8.61	9.51	5.10	15.0	14.5	14.05
Trans Fatty Acids	g/100g	0.07	0.04	0.055	4.62		9.2	0.03
Conjugated Linoleic Acid	g/100g	0.01	<0.01	<0.01				0.00
Retinol	IU/100g	242	156	199				
Beta Carotene	IU/100g	<50	<50	<50				
Retinol	mcg/100g	73	47	60				
Beta Carotene	mcg/100g	<30	<30	<30				
Total Vitamin A	IU/100g	242	156	199				
Total Vitamin A	RE/100g	73	47	60				
Vitamin D3	IU/100g	77	147	112	17.82	<2		
Vitamin E	IU/100g	1.9	2.16	2.03	1.86	<1	0.367	
Vitamin E	mg/100g	1.3	1.4	1.35				

NFR: Nova Free Ranger; WR: White Rock; Mean: between NFR and WR; APPPA: mean results from all pasture-raised chickens from the American Pastured Poultry Producers Association (1); USDA: United States Department of Agriculture values for conventional store-bought chicken (3); CFC; mean results from meat and skin samples from Chicken Farmers of Canada's nutritional analysis (8).

Table 5. Cost associated with raising Nova Free Ranger and White Rock groups on pasture at Burdock Grove, summer 2016*

FIXED COSTS	Nova Free Ranger	White Rock
Chick cost	\$305 + \$180 gas and time =\$485 =\$1.55/kg	\$229.08 + \$17 \$246.08 =\$0.82/kg
Feed cost	\$71.50 starter + \$445.0 grower = \$517 or \$1.65/kg	\$104.50 starter + \$462 grower = \$556.60 or \$1.85/kg
Butchering cost	\$787.26** or \$2.52/kg	\$827.06 or \$2.75/kg
Total cost	\$5.72/kg or \$1,789.26	\$5.43/kg or \$1,629.64
Price	\$11.02/kg (\$5.00/lb)	\$10.47/kg (\$4.75/lb)
Potential revenue	\$3,445.55	\$3,144.93
Return to labour	\$1,656.29 or \$5.30/kg (\$2.40/lb)	\$1,515.29 or \$5.05/kg (\$2.29/lb)

* Based on total weight of 312.6 kg (689.11 lb) for NFRs and 300.3 kg (662.09 lb) for WRs.

** Less shrink wrap charged for smaller pieced NFR breasts.