FOREWORD

Dear Reader,

Nearly five years ago, I pitched an idea to the Global Animal Partnership (G.A.P.) Board of Directors to lead change for broiler chickens in North America in a way that had never been done before. We'd heard from many producers that modern commercial broilers were harder to grow than ever, that the prevalence of woody breast and white striping was frustrating, and that maybe the drive for efficiency and breast meat yield had gone just a little bit too far. For G.A.P., we already knew that animal welfare was impacted by genetics, so it seemed the perfect opportunity to take a hard look at the broiler chicken breeds approved for use in our standard.

Looking to leverage our diverse partner base, the large number of broiler chickens certified to G.A.P. standards annually, our multi-tiered standard, and our commitment to using science-based evidence to guide our standards, we started to map how we could actually support and make a change with the breeds approved for use in the G.A.P. program. G.A.P. is always looking at the latest scientific research to help plan any changes to future standards. While we found some compelling evidence, it wasn't a complete picture, and we felt this level of change really needed a multi-disciplinary approach. The idea for a study that looked not only at animal welfare and behavior, but meat quality, anatomy, mobility, as well as feed efficiency and other production measures, was our proposed solution. With such a wide scope, we knew that of the many possible research facilities, the University of Guelph had the best expertise and team to make it happen.

Ambitious in design, innovative and comprehensive in approach, the summary report on the following pages outlines some of the research team's findings. This research study will make a significant contribution to the scientific literature across many fields, and will play a pivotal role 'in pursuing a better broiler'.

Anne Malleau
Executive Director, Global Animal Partnership

Final Research Results Report Prepared for Global Animal Partnership

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IMPROVE LIFE.

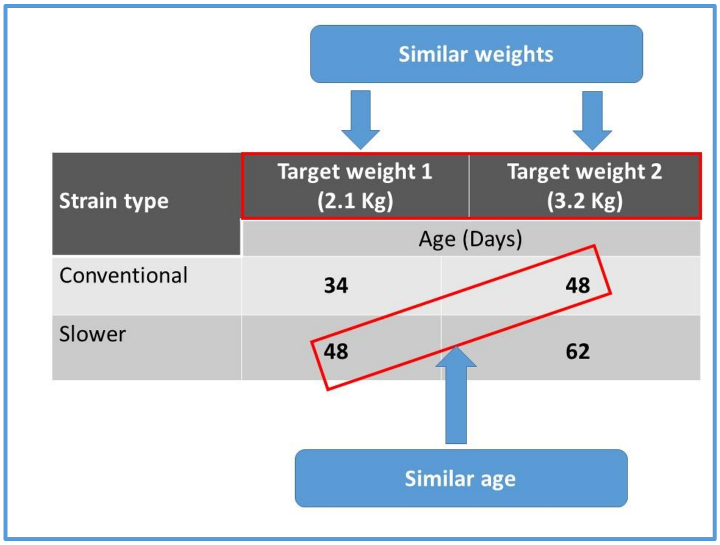
In Pursuit Of A Better Broiler: A Comprehensive Study On 16 Strains Of Broiler Chickens Differing In Growth Rates

To meet the changing and growing consumer demand for chicken meat, the poultry industry has selected broiler chickens for increasing efficiency and breast yield. While this high productivity means affordable, consistent product, it has come at a cost to broiler welfare. There has been increasing advocacy and consumer pressure on primary breeders, producers, processors and retailers to improve the welfare of the billions of chickens processed annually. Several small-scale studies have reported better welfare outcomes for slower growing strains compared to fast growing, conventional strains. However, these studies often housed birds with range access or used strains with vastly different growth rates. Additionally, there may be traits other than growth, such as body conformation, that affect welfare. As the global poultry industry considers the implications of using slower strains, there was a need for a comprehensive, multidisciplinary examination of broiler chickens with a wide range of genotypes differing in growth rate and other phenotypic traits.

Our scientific team at Guelph, including expertise in animal welfare science, poultry nutrition, meat science, immunology, physiology, phenomics and biostatistics, designed this study to benchmark data on conventional and slower growing strains of broiler chickens reared under identical conditions. **We studied over 7,500 broiler chickens from 16 different genetic strains over a two-year period with the objective to understand differences in behaviour, mobility, anatomy, physiology, mortality, feed efficiency and carcass and meat quality as they relate to the strains' growth rates.** We categorized strains by growth rate (as conventional (CONV), fastest slow strains (FAST), moderate slow strains (MOD) and slowest slow strains (SLOW)) to facilitate decision makers in their policy development, breeding goals or purchasing decisions based on animal welfare, production, efficiency and product quality.

Categorization of strains based on average daily gain (ADG) to Target Weight 2 (approximately 3.2 kg). Due to small sample size, strains A and T are included for descriptive purposes only.

Strain	ADG, g/d		Category
	Target weight 1	Target weight 2	
A	49.12	62.65	-
B	54.03	68.70	CONV
C	55.26	66.01	CONV
M	51.97	55.46	FAST
F	53.08	55.29	FAST
I	47.10	54.65	FAST
G	47.40	53.54	FAST
H	47.86	51.22	MOD
E	53.27	50.83	MOD
S	45.57	50.61	MOD
O	47.78	50.15	MOD
J	42.73	47.73	SLOW
D	42.44	45.56	SLOW
N	39.82	44.06	SLOW
K	39.31	43.58	SLOW
T	--	19.78	-

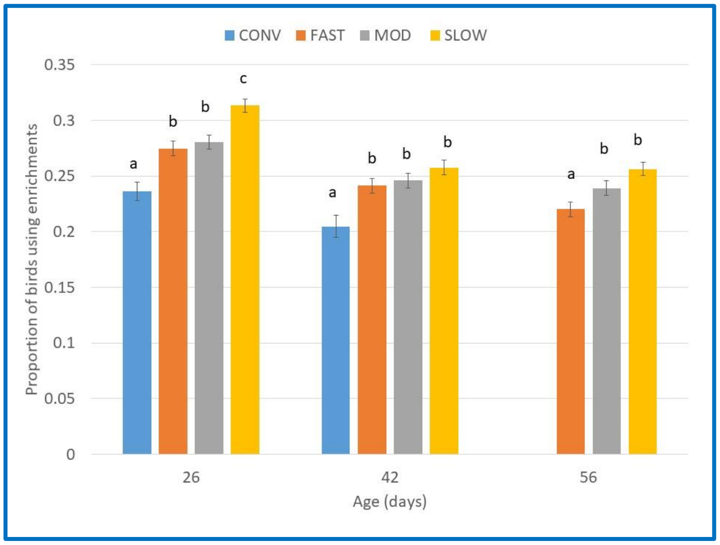


We examined the strains at similar body weights (Target Weights) and similar ages, to understand if any differences related to weight or age.

Within the same experimental room, strains were reared over eight trials and housed in identical pens at 30 kg/m^2 (placement of 44 birds/pen) with enrichments that facilitated physical and oral activity.

Environmental enrichments within the experimental pens. Birds are on the raised platform, on the ramp to the platform, perching on the water line, standing on the mineral Peckstone and interacting with the rope. A hanging scale was also available.

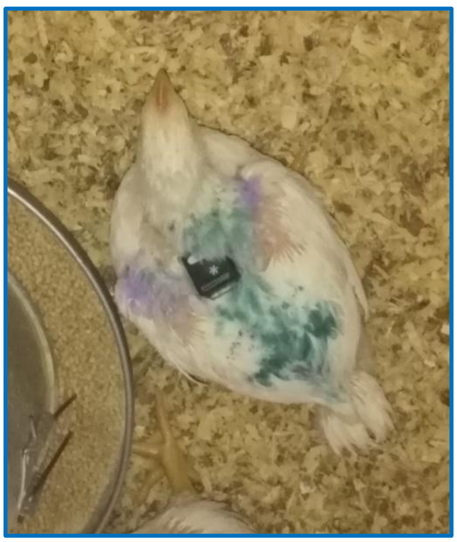
We studied the **broilers' welfare** by considering whether they might be experiencing pain or poor health, and whether they can perform motivated behaviour. We examined the potential for pain indirectly through the birds' general behaviour and activity levels, through tests of mobility and through the presence of painful footpad lesions and hock burns. The fastest growing strains spent more time sitting, and less time standing and walking than slower strains, even at the same ages. For example, at 26 days of age, CONV strains spent 73.6% of their time sitting, 4.2% of their time standing and 2.3% of their time walking. At the same age, all other strains spent an average of 63% of their time sitting, 7.8% of their time standing, and 4.3% of their time walking. **Time spent sitting, standing and walking can be an important welfare indicator if differences relate to a bird's inability to stand and walk, or if differences increase the birds' risk for contact dermatitis (footpad lesions and hock burns).**



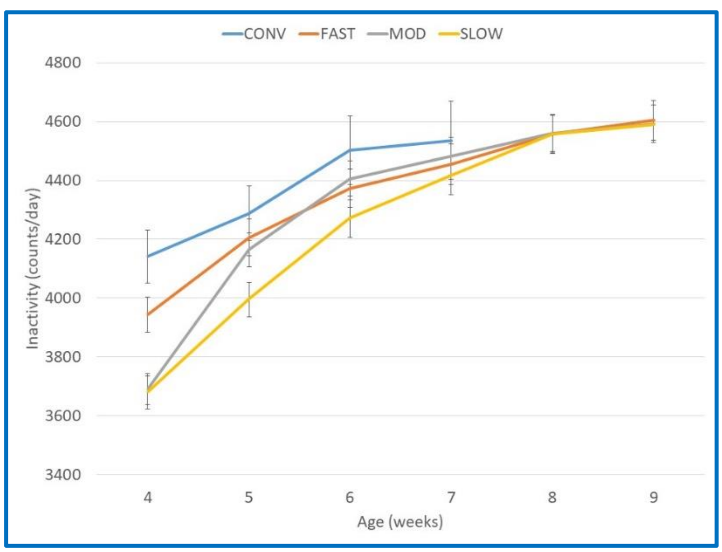
All birds decreased use of enrichments with age, but the SLOW strains used the enrichments more than faster growing strains at all ages. **Use of enrichment may reflect physical capabilities, space limitations or individual temperament.**

Differences among categories in use of enrichments over time. The CONV (in blue) and FAST strains (in orange) used the enrichments the least. Different superscripts indicate differences within an age

We outfitted a sub-sample of birds with wearable devices to measure their inactivity levels over time. Birds spent a large majority of their time (70-80%) inactive, and inactivity increased with age for all strains. However, inactivity corresponded with growth rate; faster growing birds were more inactive than slower growing birds at the same age. **Inactivity becomes a welfare concern if the birds are motivated to be active and cannot due to physical limitations, or if the inactivity itself causes welfare issues such as contact dermatitis.**



A broiler with an Actical® activity monitor on its back. We used flexible cotton straps placed around their wings to make a 'backpack' for the birds with the 22 g device. This bird was also coloured for easy identification within the group

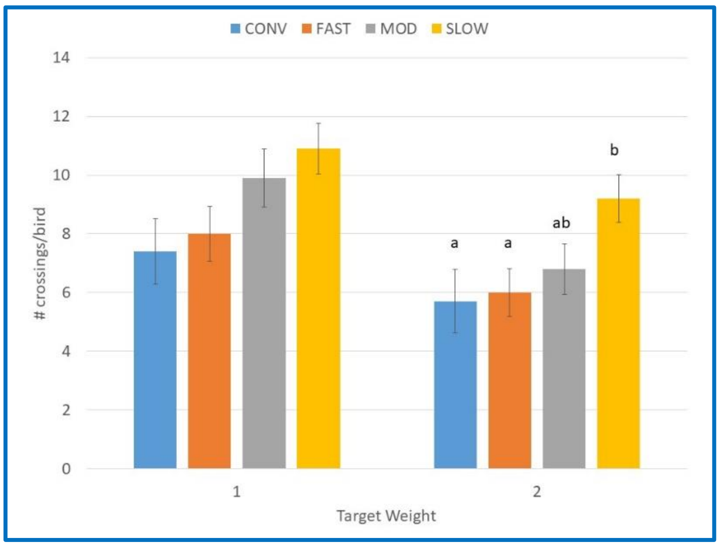


Differences in inactivity among categories of strains over time. CONV strains (in blue) were more inactive than other strains at 4 and 5 weeks of age. FAST strains were more inactive than slower growing strains at 4 weeks of age.

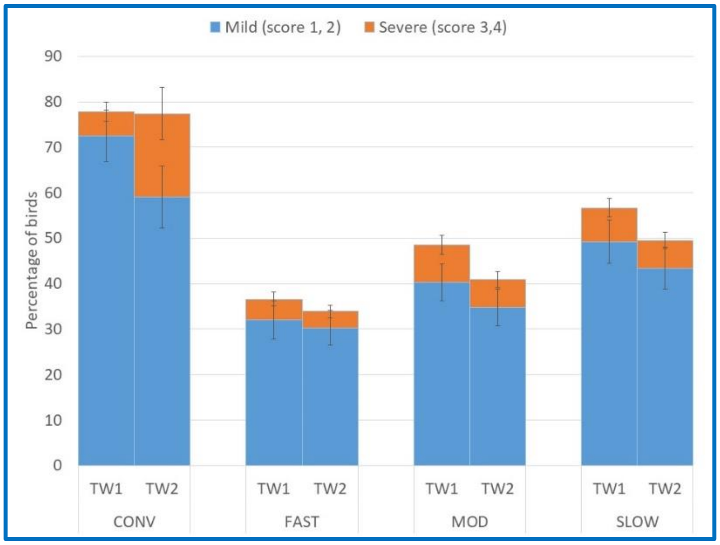
Group Obstacle Test. In this test, the feeder was removed one hour prior to the test. Birds were moved to the back of the pen and a wooden beam was placed between the feeder and drinker for a 5-hour period. Birds had to cross the beam to access feed and water. We measured the number of times the sentinel (painted) birds crossed the beam.

To study birds' mobility, we used two behavioural tests: the latency to lie test and the group obstacle test. These two tests have been validated against traditional gait-scoring systems and permit objective comparisons between strains that naturally vary in body size, leg length and conformation. The latency to lie test evaluates birds' ability to avoid a potentially aversive experience, sitting in water, by remaining standing during the 10-minute test period. When tested at the first target weight, the latency to lie corresponded with body weight; heavier birds had shorter latencies to lie than lighter birds. At the second target weight, the latency to lie corresponded with growth rate; faster growing strains had shorter latencies to lie than slower growing strains. **This may indicate differences in muscle fatigue related to growth that limits faster growing strains in supporting their body weight.**

Differences in number of crossings during group obstacle test among categories of strains prior to Target Weights 1 and 2. There were fewer obstacle crossings with increasing growth rates.



The obstacle test evaluates broilers' ability or motivation to cross a physical barrier to access feed and water. Over the five-hour long group obstacle test, the number of crossings corresponded with growth rate, with CONV and FAST crossing the obstacle fewer times than SLOW strains. **This difference may indicate differences in functional leg strength that may limit the fastest growing strains from accessing important resources.**



Mild and severe footpad lesion scores by category and target weight.

The CONV and SLOW strains had the worst footpad lesion scores. These lesions relate to poor litter condition, influenced by different behaviour patterns. For the conventional strains, their high feed intake (and excreta output) coupled with low activity levels caused poor litter conditions. For SLOW strains, their use of enrichments (including perching on the drinker lines) may have caused water leakage and inconsistent litter conditions. The CONV and FAST strains had worse hock burn scores, which relates to the time they spent sitting on wet litter**. In general, growth rate reduced activity levels, mobility and interactions with environmental enrichments, and was related to increased footpad lesions and hock burns, which are known to be painful.**

When looking at the **broilers' health**, we found no effect of growth rate on mortality and there were no disease outbreaks, despite the use of an antibiotic-free diet. Overall mortality was 2.52%. There were also few indicators of ascites or bone quality issues, such as tibial dyschondroplasia and long bone deformities, indicating the successful incorporation of these factors into selection indices across strains. The CONV strains also had the strongest tibiae.

Differences in relative tibia breaking strength (TBS, N/kg) among categories of strains at Target Weights 1 and 2. Different superscripts denote differences within target weight.

	Target Weight 1		Target Weight 2	
	BW (g)	TBS (N/kg)	BW (g)	TBS (N/kg)
CONV	1857.8 ± 40.85[d]	155.6 ± 6.84[a]	3272.1 ± 59.39[ab]	111.5 ± 3.95[a]
FAST	2519.6 ± 38.45[a]	120.7 ± 3.60[c]	3438.6 ± 48.30[a]	94.8 ± 2.58[b]
MOD	2359.8 ± 34.09[b]	121.0 ± 3.43[c]	3190.4 ± 42.13[b]	99.4 ± 2.57[b]
SLOW	2014.6 ± 28.97[c]	134.1 ± 3.77[b]	2846.5 ± 37.44[c]	112.6 ± 2.89[a]

There were also differences in biochemical indicators of metabolic dysfunction and relative organ weights that related to growth rates and breast yield. Strains that had the highest growth rates and breast yields had the highest concentrations of biochemical markers associated with muscle damage. The fastest growing strains had disproportionate heart and lung development, which may negatively influence their cardiopulmonary functioning.

- CONV had >50% higher concentrations of aspartate transaminase (AST), creatine kinase (CK) and lactate dehydrogenase (LDH) than other strains. Strains with the highest breast yield had the highest concentrations of AST, CK and LDH.
- CONV had 5-18% heavier relative heart weights (controlled for BW), and 3-14% lighter relative lung weights (controlled for BW) than other strains.

When considering **production, efficiency and product quality**, strains differed in their body weights, growth rates, feed intake and feed efficiency. The fastest growing stains had the highest feed intake and best feed efficiency. Slower growing strains had feed conversion ratios that were 13-43 points higher (worse) than CONV.

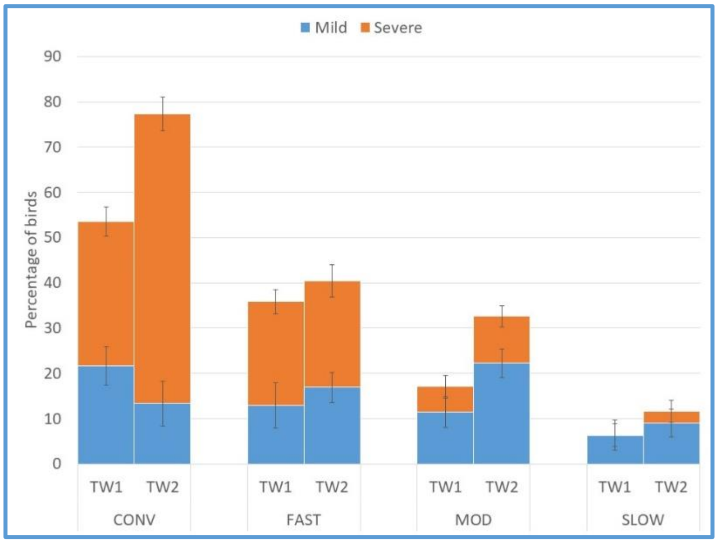
Production and efficiency of categories of broiler chickens at Target Weights 1 and 2. At TW1, CONV was 34 d of age and the other categories were 48 d of age. At TW2, CONV was 48 d of age and the other categories were 62 d of age. Different superscripts within a row signify significant differences. All variables were corrected for mortality.

		CONV	FAST	MOD	SLOW
BW (kg)	**TW1**	1.838 ± 0.0674[b]	2.367 ± 0.0567[a]	2.340 ± 0.0547[a]	1.938 ± 0.0554[b]
	TW2	3.202 ± 0.0674[b]	3.433 ± 0.0567[a]	3.170 ± 0.0559[b]	2.813 ± 0.0549[c]
ADG (g)	**TW1**	55.86 ± 1.245[a]	51.38 ± 1.004[b]	50.27 ± 0.948[b]	41.85 ± 0.965[c]
	TW2	68.92 ± 1.246[a]	56.03 ± 1.004[b]	51.79 ± 0.986[c]	46.13 ± 0.951[d]
ADFI (g)	**TW1**	87.19 ± 2.084[a]	83.78 ± 2.201[b]	80.39 ± 2.179[b]	74.34 ± 2.389[c]
	TW2	102.90 ± 2.498[a]	97.54 ± 2.201[ab]	96.36 ± 2.180[b]	89.93 ± 2.168[c]
FCR	**TW1**	1.49 ± 0.035[a]	1.70 ± 0.048[bc]	1.62 ± 0.047[b]	1.82 ± 0.056[c]
	TW2	1.54 ± 0.061[a]	1.76 ± 0.048[b]	1.89 ± 0.047[c]	1.97 ± 0.046[c]

All but the slowest strains had similar carcass yields, but there were differences in carcass composition depending on growth rate. The fastest growing strains had the highest breast yield and lowest thigh, drumstick and wing yields.

- Carcass yields for CONV, FAST and MOD were higher than for SLOW.
- Breast yields increased with increasing growth rates; thigh, drumstick and wing yields decreased with increasing growth rates.

Prevalence of mild and severe wooden breast by category and target weight.



Growth rate and breast yield affected the prevalence and severity of wooden breast and white striping, muscle myopathies that can lead to carcass downgrading or condemnation. Strains with the highest breast yield had high prevalence of these myopathies.

In summary, we found that conventional strains of broiler chickens grew faster, more efficiently and had higher breast yields than did slower growing strains. However, there are significant trade-offs for this high productivity. In comparison to strains with slower growth rates and lighter breast yields, strains with faster growth rates and higher breast yields had lower activity levels, poorer indicators of mobility, poorer foot and hock health, higher biochemical markers of muscle damage, higher rates of muscle myopathies, and potentially inadequate organ development. Fast growth rate coupled with high breast yield is associated with poor welfare outcomes.