BLOOD ANALYSIS & PROPORTIONAL MUSCLE AND ORGAN WEIGHTS IN BROILERS WITH WOODEN BREAST

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The objective of this study was to enhance the current systemic characterization of wooden breast myopathy by comparing 13 blood parameters and 8 muscle and organ weights between affected and unaffected broilers. The correlation between body weight and wooden breast in early (13 days) and late (7 weeks) disease periods for both males and females was also evaluated.

METHODS

As part of a large genome-wide association study to understand the genetic basis of susceptibility to wooden breast in commercial broiler chickens, more than 2000 Cobb500 broilers were raised to approximately 7 weeks of age and scored for wooden breast from 0 (unaffected) to 3 (severely affected). A subgroup of 103 7-week-old broilers (55 affected, 48 unaffected) were used to determine the effect of wooden breast on 13 blood parameters and the relative weights of the dissected left pectoralis major muscle, left pectoralis minor muscle, left external oblique muscle, whole feathered left wing, heart, lungs, liver, and spleen. Blood analysis was performed with the i-STAT handheld blood analyzer on samples taken from the brachial vein of live birds.

RESULTS & DISCUSSION

1. Males had higher prevalence and severity of wooden breast than females. Body weight at 13 days and calculated body weight at 49 days showed significant linear effects (p-value < 0.0001) on WB score for both males and females (Figure 2).
2. Blood analysis revealed significant differences in blood gases between affected and unaffected chickens, with affected chickens exhibiting higher partial pressure of CO_2, total CO_2, bicarbonate, and base excess, and lower partial pressure of O_2, oxygen saturation, and pH (Table 1). Increased CO_2 and decreased O_2 in venous blood of affected broilers suggest greater metabolic demand and insufficient gas exchange, potentially caused by disturbances in circulation, cardiac output, or respiration.
3. Wooden breast affected broilers possessed a significantly larger pectoralis major muscle and full wing relative to body weight. Notably, the external oblique (a respiratory muscle involved in expiration) did not show proportional growth with the pectoralis major in affected birds (Figure 1).

		Na mmol/L	K mmol/L	iCa mmol/L	Glu mmol/L	Hct %PCV	Hb g/dL	pH	pCO_2 mmHg	pO_2 mmHg	TCO_2 mmol/L	HCO_3 mmol/L	BE mmol/L	sO_2 %
Affected n=55	Mean	149.95	5.03	1.41	222.04	23.60	8.02	7.36	47.92	39.44	28.49	27.06	1.69	70.04
	SD	2.52	0.39	0.08	13.59	3.01	1.03	0.05	8.63	6.45	3.21	2.98	3.03	10.35
Unaffected n=48	Mean	149.46	4.91	1.39	223.48	23.08	7.85	7.39	42.10	44.98	26.67	25.38	0.38	79.54
	SD	2.76	0.40	0.08	11.28	2.84	0.98	0.04	4.96	4.77	2.37	2.30	2.64	4.89
Significance								**	****	****	**	**	*	****

Table 1. Blood analysis statistics in wooden breast affected and unaffected broiler chickens. Significant differences were observed between wooden breast affected and unaffected broiler chickens in pH, partial pressure of carbon dioxide (pCO2), partial pressure of oxygen (pO2), total carbon dioxide (TCO2), bicarbonate (HCO3), base excess (BE), and oxygen saturation (sO2). No significant difference was observed for sodium (Na), potassium (K), ionized calcium (iCa), glucose (Glu), hematocrit (Hct), or hemoglobin (Hb) values across bird groups. Significance thresholds: * < 0.05, ** < 0.01, *** <0.001, **** < 0.0001.

ACKNOWLEDGEMENTS

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Cobb-Vantress generously provided the day-old chickens and chicken feed used in this experiment.

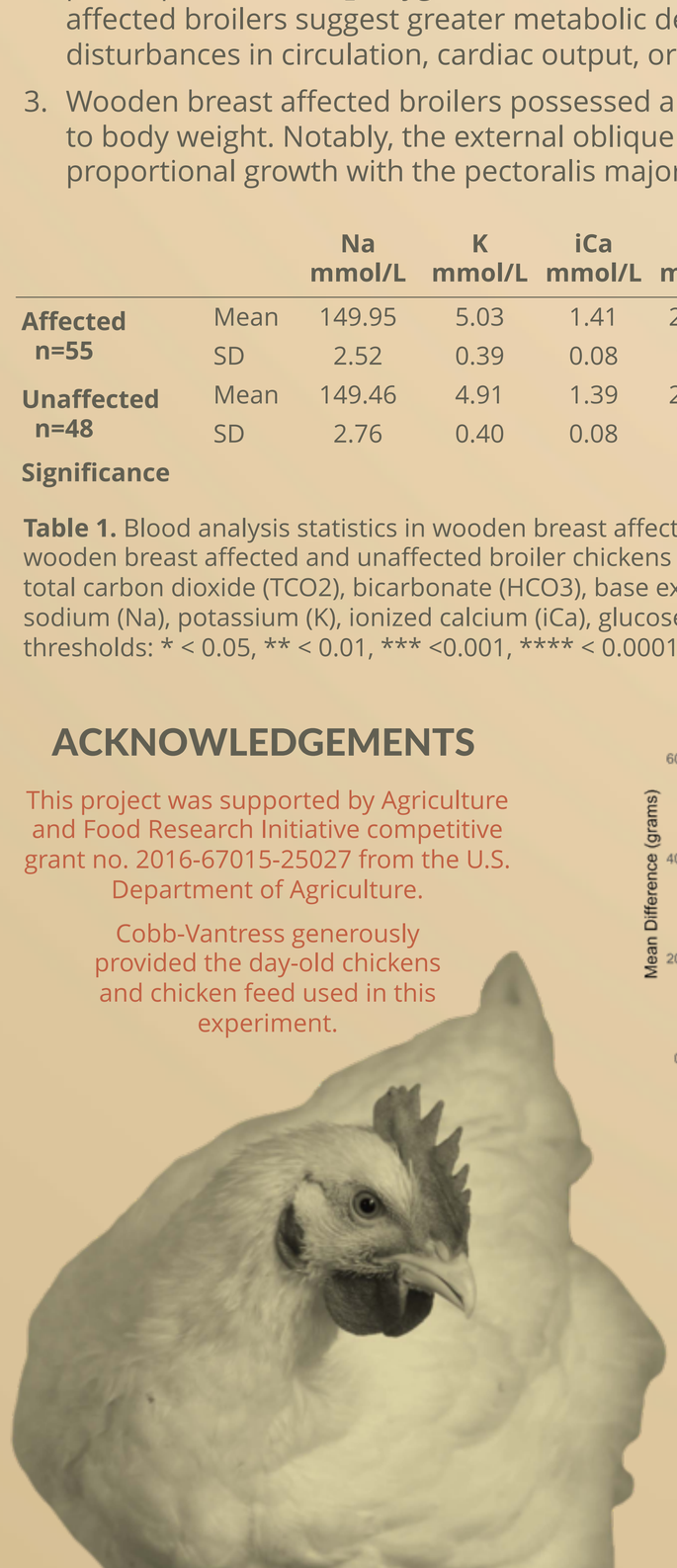


Figure 1. Mean differences in body part weights between males and females (grey) and wooden breast affected and unaffected (red) for subset of 103 broilers. Significance of each mean difference was determined after controlling for body weight. Significance thresholds: * < 0.05, ** < 0.01, *** <0.001, **** < 0.0001.

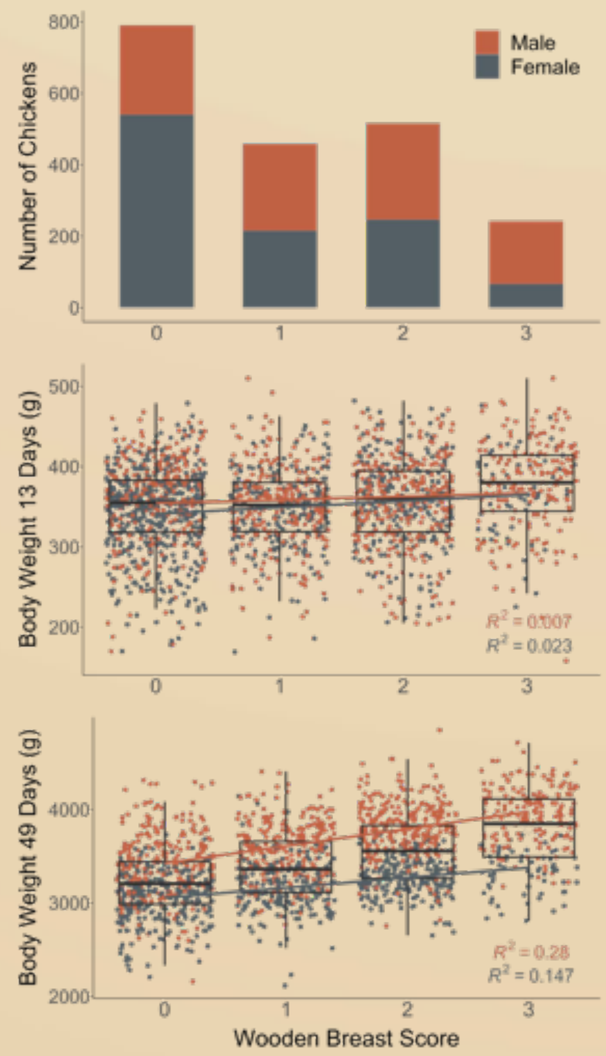


Figure 2. Effect of gender (top), body weight at 13 days (middle), and body weight at 49 days (bottom) on wooden breast score. Body weight at 49 days was corrected for the fact that chickens were processed at slightly different ages (47 to 52 days of age).

CONCLUSIONS & FUTURE WORK

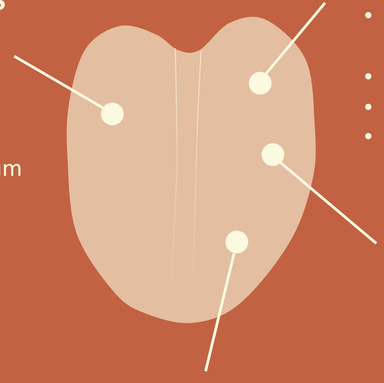
The accumulation of CO_2 and simultaneous depletion of O_2 in tissue and venous blood occurs when the metabolic demands of the tissue exceed the capacity of the respiratory or circulatory system. The causes of increased metabolic demand in modern broiler chickens are readily apparent from existing literature, but the precise mechanisms of inadequate respiratory gas exchange in wooden breast affected chickens requires additional research. Potential respiratory and circulatory disturbances might include disproportionate growth of respiratory muscles compared to breast muscle tissue, demonstrated in the present study, and impaired venous return from phlebitis, which was established in previous studies. Additional research is needed to evaluate the severity, cause, and impact of impaired respiratory exchange in order to determine if systemic circulatory or respiratory insufficiency might be a significant contributor to wooden breast disease development.

WHAT IS WOODEN BREAST?

Wooden breast is one of several muscle disorders of commercial broiler chickens that have manifested alongside intense genetic selection for production traits such as high muscle yield, rapid growth, and high feed efficiency. The myopathy is characterized by increased firmness of the breast muscle, caused by fibrosis, myofiber swelling, myofibrillar disintegration, and tissue edema; however, venous inflammation (phlebitis) and perivascular lipid and inflammatory cell infiltration are known to appear in the first week of age and precede myofiber degeneration and necrosis. Other signs and symptoms of the disease, as evidenced by histopathologic examination, differential expression analysis, and metabolomics research, are listed below.

Molecular signs and symptoms

- oxidative stress
- accumulation of fatty acids
- altered lipid and carbohydrate metabolism
- accumulation of intracellular calcium
- hypoxia



Microscopic signs and symptoms

- venous inflammation (phlebitis)
- perivascular lipid and inflammatory cell infiltration
- fibrosis
- myofibrillar disintegration
- myofiber degeneration & necrosis

Visible signs and symptoms

- pale and hardened areas
- white stripes
- subcutaneous and fascial edema
- petechial hemorrhages

Clinical signs and symptoms

- decreased wing movement
- locomotor difficulties

$200 million

a conservative estimate of annual losses resulting directly from yield loss, downgrading, and discarding of wooden breast affected breast meat in the U.S.

WHY WOODEN BREAST MATTERS

Wooden breast is prevalent in geographic areas that raise broilers for markets that value the breast muscle over dark meat, including the United States, Europe, Brazil, and most recently Thailand, with incidence rates sometimes exceeding 50% of individual flocks and approximately 10% of flocks displaying the most severe form of the disease. Wooden breast causes such extreme degradation of meat quality and appearance that moderately or severely affected breast muscle is generally downgraded, rendered, or discarded.