NYWGF RESEARCH - FINAL REPORT TEMPLATE

Please fill in by typing over the red directions in each section and change font to black.

Funding for fiscal year: 2025-2026

SECTION 1:

Project title: Upcycling Grape Pomace As Dietary Ingredient To Treat Coccidiosis in Poultry Production

Principal Investigator with contact info: Dr. Elad Tako, Associate Professor, Department of Food Science, Cornell University (et79@cornell.edu)
Co-PI Collaborators with contact info:

New Research ☐ **Continued Research** ☒ (CHECK APPROPRIATE BOX)

Amount Funded **$**54,000 with $30,000 coming from EJ Gallo and $24,000 from NYWGF

SECTION 2: (This section should be in depth and akin to an academic report)

Project Summary Impact Statement: This project aims to address environmental and economic challenges by utilizing grape pomace (GP), a byproduct of grape processing, as a sustainable feed additive for poultry production. Grapes are the highest-producing fruit in the U.S., but 20% of their volume remains as pomace after processing, creating environmental and economic challenges. Meanwhile, poultry production is rapidly increasing, but the removal of antibiotic growth promoters (AGPs) has led to higher disease rates, particularly Coccidiosis, which causes an estimated $15 billion in global losses. Coccidiosis weakens chickens' health, affecting growth, feed efficiency, and high mortality rates. Despite efforts like biosecurity and vaccination, limitations in efficacy and consumer demand for antibiotic-free products require sustainable alternatives. GP, rich in bioactive polyphenols with antimicrobial, antioxidant, and anti-inflammatory properties, offers a sustainable solution. We have shown that dietary GP can reduce low-grade chronic inflammation in poultry. Incorporating GP into poultry feed not only helps manage waste and pollution but also enhances gut health and productivity, providing an AGP alternative. Further research on GP's effectiveness in treating Coccidiosis and its large-scale use can optimize processes and create new markets. This proposal aligns with the theme of vineyard sustainability, aiming to revalorize GP for sustainable poultry production while reducing environmental pollution and antibiotic-related public health risks.

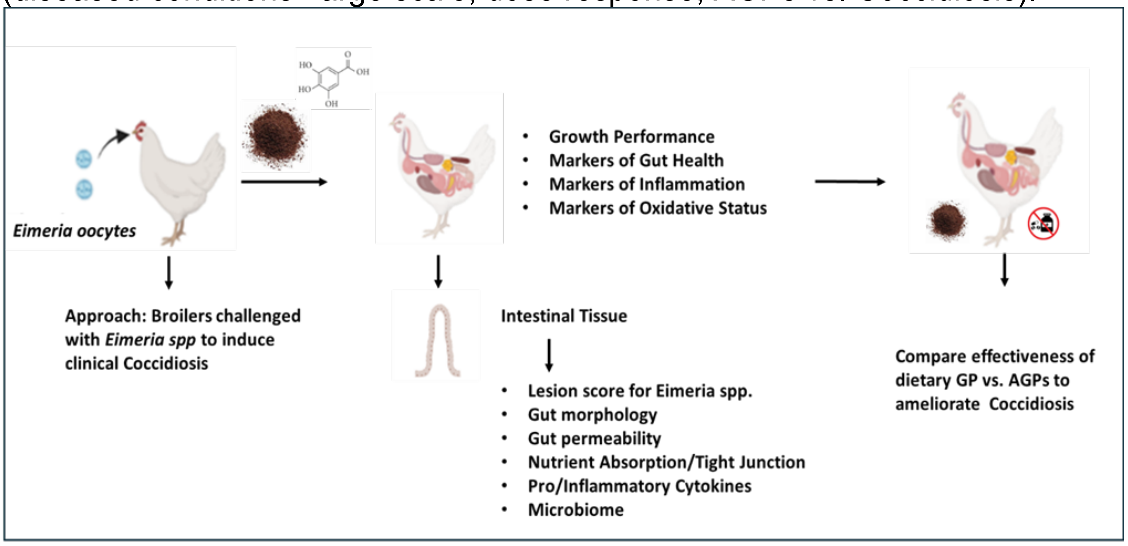
Impacts: 1. More sustainable use of GP reduces disposal and environmental burdens, **2.** Using GP improves poultry health and productivity, focus on coccidiosis, major poultry disease ($15B annual loss, globally) **3.** GP utilization limits emergence of antibiotic-resistant bacteria, and, **4.** Additional economic vitality of the grape and wine industry through sales of GP to feed producers.

Objectives: The overall goal of this project is to repurpose GP as an innovative feed additive to replace the AGP while lowering feed costs, mitigating environmental pollution from its disposal, and enhancing broiler performance, health, and immune response. The specific research objectives identified to help achieve this goal are listed below:

Objective 1: Evaluating the dietary inclusion of the Concord GP (*Vitis labrusca* L.) to mitigate the negative effect of coccidiosis, via large scale, long-term feeding trial in infected broilers (Coccidiosis) (dietary GP dose response of 0.5%, and 0.75%).

Objective 2: Evaluating the potential of dietary Concord GP (*Vitis labrusca* L.) to reverse negative effects of Coccidiosis on microbiome, and beneficial metabolites (SCFA), in infected broilers (Coccidiosis).

Figure 1. Schematic diagram of project focus. Utilizing waste, by-product grape pomace as alternatives to antibiotic growth promoters to ameliorate Coccidiosis in poultry production (diseased conditions- large scale, dose response, AGPs vs. Coccidiosis).



Materials & Methods:

<u>**Objective 1:**</u> We hypothesize that the dietary inclusion of We hypothesized that dietary inclusion of GP will improve gut health and ameliorate the negative effects of coccidiosis in infected broilers through antimicrobial, anti-inflammatory, and antioxidant characteristics of its bioactive compounds, thereby improving overall poultry health and performance.

i. In vivo study. On day of hatch, a total of 100 non-vaccinated Cobb 500 male chicks will be randomly allocated into four treatment groups (n=25) **(1) NCC**: non-challenge control; **(2) CC**: challenged control (challenged with 20 X dose of Coccidiosis vaccine); **(3) 0.5GP**: 0.5% Grape Pomace inclusion and challenged with 20 X dose of Coccidiosis vaccine; **(4) 0.75GP**: 0.75% Grape Pomace inclusion and challenged with 20 X dose of Coccidiosis vaccine. At 14 d, birds will be challenged with 20 X dose of Coccidiosis vaccine (containing 7,500 sporulated oocysts of E. maxima, 7,500 sporulated oocysts of E. tenella, and 25,000 sporulated oocysts of E. acervuline) to induce coccidiosis disease. To mimic the challenge, the non-challenge control group will be injected with 1 mL of distilled water. The experiment was conducted in floor pens to closely simulate commercial standards and facilitate the recycling of oocysts following Eimeria inoculation at the Cornell University Baker Institution facility. The broilers will be fed a phase-specific diet (Starter, grower, and finisher), all of which meet or exceed the nutrient requirements for Cobb 500 broilers (*ad libitum*). The corn and soybean meal-based diets will be isocaloric and isonitrogenous for all the treatment groups throughout the experimental period. Figure 2 shows the experimental approach and timeline for the proposed in-vivo experiment. The feed intake per replicate group was monitored weekly between 0-26 days. Following the Eimeria spp. inoculation at 14 days, feed intake will be monitored daily from 0 to 14 days post-inoculation (DPI). The growth performance of the broilers, assessed via body weights (BW) and body weight gain (BWG), will be measured every week prior to inoculation, then again at 6 and 11 DPI. The feed conversion ratio (FCR) will be measured at the end of each feeding period (starter, grower, and finisher) and total (0-26 d) as g feed intake per g body weight gain (Feed intake/body weight gain). Indicators of gut health and oxidative status will be measured in the Tako lab from 1 bird per replicate on 6 and 11 DPI, whereas the lesion score will be measured from 3 additional birds only at 6 DPI. Our sampling strategy for each measurement is summarized in Table 3 (IACUC protocol code #2020-0077).

Figure 2. Experimental approach and study design.

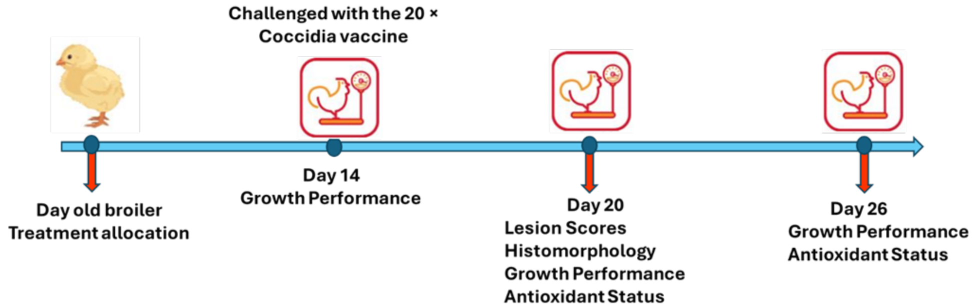


Table 3: Sampling strategy for in vivo study

Measurement	Sample Collected	DPI
Lesions score for *Eimeria spp*.	• Upper intestine • Middle intestine • Ceca	6
Histomorphology	• Duodenum • Jejunum • Ileum	6,11
Gut permeability	• Blood	5
Nutrient transporters, and tight junction proteins	• Duodenum	6,11
Inflammatory, proinflammatory cytokines	• Cecal tonsils	6,11

ii. Grape Pomace Processing. The grape pomace variety chosen is the Concord grape (*Vitis labrusca* L.), as we have previously performed an intra-amniotic preliminary study with it (Agarwal et al., 2022), and a preliminary feeding trial (Sharma et al., under review; Sharma et al., 2025). This allowed us to build on previous data and experience. Concord grapes are widely cultivated around the NY Finger Lakes District, Lake Erie, Lake Ontario, Southwestern Michigan, and the Yakima Valley in Washington. Although we believe this study would also apply to other grape varieties as their phytochemical composition is largely the same. **Processing.** Previous studies on GP have not clearly described the manufacturing process for preparing the GP. This is crucial as this would determine the phytochemical profile and microbial load of the feed. For this project, we oven dried the GP at a maximum of 60°C until moisture is less than 10%. This is to ensure phytocompound stability and future scalability. This oven drying can be done commercially, irrespective of sunlight availability. The concord GP was provided by by industry collaborator: Canandaigua winery/Gallo. The GP drying was conducted by Pure Functional Foods (Savannah, NY). **GP quality testing.** In addition to testing moisture content, we propose testing total polyphenol, monomeric anthocyanin, crude protein, condensed tannin, neutral detergent fiber, and non-fiber carbohydrates content in the processed GP (Table 4). This allowed us to make predictions for the outcome in the broilers and help us understand the physiological effects we see at the end of the study. We will test for microbial activity following industrial standard testing methods, including total plate count, total coliforms, yeast, and mold. The microbial profile of the feed can have a significant impact on the gut microbiome and the overall health of the broilers. Testing would ensure the physiological effects are due to the phytochemistry of GP (which can be consistent to an extent) and not due to its microbial profile (which varies drastically based on the environment).

Table 4. Concord GP phenolic profile

Source: Melissa Y. Huang, Eliot M. Dugan, Elad Tako, Concord grape (Vitis labrusca 'Concord') pomace extract impacts dextran sulfate sodium-induced inflammation in ovo (Gallus gallus), Journal of Functional Foods, Volume 129, 2025, 106840, ISSN 1756-4646, https://doi.org/10.1016/j.jff.2025.106840.

Compound	mg/L filtrate	mg/kg dry GP
gallic acid	3.00	60.0
ethyl gallate	1.38	27.6
protocatechuic acid	nd	nd
ethyl protocatechuate	nd	nd
syringic acid	0.75	15.0
caffeic acid	nd	nd
p-coumaric acid	0.90	18.0
ferulic acid	0.94	18.8
ethyl ferulate	nd	nd
total hydroxycinnamic acids	2.44	48.8
astilbin	2.61	52.2
catechin	2.20	44.0
epicatechin	nd	nd
engeletin	nd	nd
isorhamnetin 3-O-glucoside	nd	nd
quercetin glycosides	2.69	53.8
quercetin dihydrate	nd	nd
total anthocyanins	63.13	1262.2
total polymeric tannins	27.81	556.2

iii. Dose/percent Dietary Inclusion. We propose testing 2 doses of GP (0.5, and 0.75% GP). This is justified based on previous data that included large-scale poultry studies (n=25/treatment, Table 5).

Table 5. experimental groups

Group #	Treatment
1	Non-challenged control (NCC)
2	Challenged control (CC; challenged with coccidia)
3	0.5% Grape Pomace inclusion and CC (0.5GP)
4	0.75% Grape Pomace inclusion and CC (0.75GP)

* A total of 100 broilers maintained with n = 25 in each treatment group. This study was conducted in a disease controlled facility.

iv. Grape Pomace Testing. Total polyphenol content was tested using the Folin-Ciocalteu method described by Waterhouse. Total monomeric anthocyanin content will be determined using the pH differential method. The non-fibrous carbohydrate, acid detergent fiber, and neutral detergent fiber analyses will be conducted according to AOAC 962.09 and 973.18 at Dairy One Co-Op Inc (Ithaca, NY, USA). Total plate count, total coliforms, yeast, and mold will be AOAC 966.23, 991.15, and 2014.05, respectively. Heavy metals Hg, Cd, As, and Pb will be tested using ICP-MS using USP <231> (USA Pharmacopeia).

v. Intestinal Barrier Integrity. Fluorescein isothiocyanate dextran (FITC-d) (MW 3–5 KDa; Sigma Aldrich Co., MO, USA) was used as a marker to determine the extent of paracellular transport and intestinal barrier dysfunction. For the assessment, the optimized protocol specifically for broiler gut permeability will be used. In addition, duodenum and jejunum gene expression of tight junction proteins (Occludin, Zonula occludins-1, and Claudin-3,-4) was assessed to verify intestinal barrier integrity using an RT-qPCR.

vi. Inflammatory Status-related Biomarkers. Superoxide dismutase (SOD), glutathione peroxidase (GPx), and malondialdehyde (MDA) was measured in the plasma using commercially available ELISA kits to determine the antioxidant status of the birds. SOD is a detoxification enzyme component of the first line of defense against reactive oxygen species. Similarly, GPx is an important intracellular enzyme that breaks down H_2O_2 to H_2O and lipid peroxides to their corresponding alcohols. MDA is one of the final products of PUFA peroxidation, and an increase in its levels indicates excess free radicals. Additional pro-inflammatory cytokine (IL-6, NF-κB, TNF-α, and IFN γ) gene expression was determined. Further, calprotectin (CP) and alpha1-acid glycoprotein (α1-AG) have been identified as important non-invasive novel methods to assess the gut inflammation process. Plasma levels of α1-AG will be determined using a commercial radial immunodiffusion kit. Serum levels of calprotectin will be quantified using a commercial ELISA kit per its instructions.

vii. Intestinal Gut Morphology. Duodenal and jejunal brush border membrane characteristics, including villi surface area, crypt depth, and intestinal wall thickness, were determined. Transverse sections of the two samples will be fixed, paraffin-embedded, stained with H&E, and imaged under the light microbiome (BX3M series, Olympus Waltham, MA, USA). To count and measure, the CellSens Standard Software will be used.

viii. Statistical Analysis. The mean difference between treatment groups will be calculated using ANOVA followed by a Ducan post-hoc test using SPSS software version 27 (IBM, Armonk, NY, USA). Differences with *p*-values ≤ 0.05 will be considered statistically significant. The values will be represented as means ± standard deviation. Power analysis will be done using G*Power software (version 3.1.9.7) to calculate the sample size needed for each parameter.

ix. **Deliverables**: The measurements, variables, and results for our analysis are provided in Table 6. To consider GP successful in counteracting the effects of Eimeria, we aim to see improvements in growth performance by at least 6% and feed conversion ratio by at least 3 points. Additionally, a reduction in the severity of lesion scores from higher intensity to lower intensity by 18% and an improvement in tight junction integrity and intestinal morphology is expected for any of the levels tested. The optimal level of GP dietary inclusion was determined based on the level that most closely adheres to the expected results across the tested variables.

Table 6. Analyses and summary of results from the inclusion of GP in in-vivo study.

Measurement	Measured Variable	Results
Lesions score for *Eimeria spp*.	• Lesions for *E. acervulina, E. naxima, E. Tenella*	• Reduction in coccidia lesions in all three intestinal segments
Histomorphology	• Villus height, crypt depth, villus height to crypt depth ratio	• Restoring small intestinal histomorphology
Gut integrity	• Tight junction proteins	• Maintaining small intestinal tight junction integrity
Gut permeability	• Fluorescein isothiocynate dextran (FITC-d) leaked into blood	• Limited leaky intestine
Nutrient digestive enzymes and transporters genes	• Amino acis transporters • Glucose transporters	• Increased functionality of the nutrient digestive and absorptive surface (duodenal brush border membrane) by increasing the gene expression of assessed proteins
Oxidative status	• Oxidative markers (liver)	• Reduction in oxidative strees associated with coccidiosis
Inflammatory and proinflammatory cytokines	• Gene expression of inflammatory and proinflammatory cytokines	• Reduction in coccidiosis generated inflammatory response

- Data above was presented at the (1) Poultry Science Association meeting (Raleigh, NC, 2025: (A) Effects of dietary inclusion of grape pomace on physiological and molecular marker of gut health and oxidative stress in coccidia-challenged broilers (Gallus gallus); (B) Effect of dietary inclusion of fermented and non-fermented grape pomace on growth performance and gut function of broilers under chronic inflammation; (2) the Institute of Food and Technology, IFT-First (Chicago, IL, 2025): Concord grape (Vitis labrusca 'Concord') pomace extract impacts dextran sulfate sodium-induced inflammation in ovo (Gallus gallus); (3) Global symposium by Upcycled Food Foundation (The Value of Fruit Skins: Transforming Food Byproducts in to Health Benefits, Sep 29-30, 2025)
- Data was published: Sharma MK, Dugan EM, Huang MY, Jackson C, Pataki MJ, Gracey PR, McGovern CJ, Tako E. Dietary grape pomace ameliorates intestinal damage and oxidative stress by modulating MAPK-Nrf2/ARE pathways in coccidia-challenged broilers (Gallus gallus). Poult Sci. 2025 Aug;104(8):105364. doi: 10.1016/j.psj.2025.105364. Epub 2025 May 28. PMID: 40451073; PMCID: PMC12164180.

Objective 2*: We hypothesized that the dietary inclusion of Concord (*Vitis labrusca* L.) GP will reverse negative effects of Coccidiosis on gut microbiome, and beneficial metabolites (SCFA), in infected broilers (Coccidiosis).

i. Cecal Microbiome (MiSeq) Metagenomics. Cecum microbial genomic DNA was extracted using the PowerSoil DNA isolation kit. Bacterial gene sequences will be PCR-amplified using primers for the V4 hypervariable region of the 16S rRNA gene. PCR products will be quantified using a Quant–iT PicoGreen dsDNA assay. Equimolar ratios of total samples will be pooled and sequenced using a MiSeq Sequencer (Illumina). Sequences that pass quality filters were analyzed using the QIIME software package, demultiplexed by per-sample barcodes and Illumina-sequenced amplicon reads errors corrected by Divisive Amplicon Denoising Algorithm (DADA2). Sequences will be classified taxonomically using the Greengenes reference database at a confidence threshold of 99%. The Greengenes taxonomies will generate summaries of the taxonomic distributions of features across different levels (phylum, order, family, and genus). After filtration of low abundant features (observed > 2 samples per group), α and β diversity analyses will be calculated. Microbial richness, an α diversity parameter, will be calculated using Faith's Phylogenetic Diversity. β diversity will be analyzed using Jaccard similarity distances. Special attention will be given to the number of commercially relevant pathogens (*C. perfringens, E. coli*, Mycoplasma, *Salmonella*, *Staphylococcus*, *Streptococcus*, *Listeria*).

ii. Short Chain Fatty Acids analysis. Cecal and blood samples were homogenized in HCl (2 ml, 3%, 1 M), centrifuged and combined with ethyl acetate (100 µL) and acetic acid-d4 (1 µg/mL) before collecting the organic phase to determine short chain fatty acid (SCFA) composition. Samples were quantified via GC-MS using a TRACE™ 1310 gas chromatograph and a TraceGOLD™ TG-WaxMS A column (Thermo Fisher Scientific, Waltham, MA, USA).

iii. Statistical Analysis. The mean difference between treatment groups will be calculated using ANOVA followed by a Ducan post-hoc test using SPSS software version 27 (IBM, Armonk, NY, USA). Differences with p-values ≤ 0.05 will be considered statistically significant. The values will be represented as means ± standard deviation. Power analysis will be done using G*Power software (version 3.1.9.7) to calculate the sample size needed for each parameter.

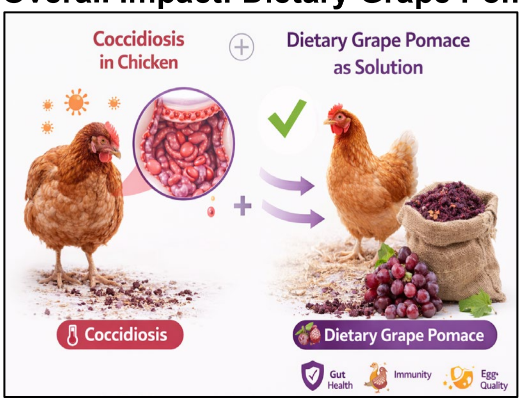
*Results were analyzed and indicated that dietary GP showed positive effects on microbial composition and function, despite disease conditions (Figure 6A,B). The relevant manuscript is in preparation.

Results/Outcomes/Next Steps: The intent of this project is to promote the use of natural feed inputs to improve environmental and agricultural industry performance. Our work is especially relevant given the state's large grape industry, converting GP from a costly byproduct to a value-added feed input that is locally available to NY poultry farms. Grape pomace, a by-product of grape pressing for wine and juice, represents 25-30% of the original grape weight, creating significant waste and disposal challenges. With poultry production expected to double by 2050, an increase in incidences of gastrointestinal diseases poses a great threat to poultry production. Additionally, poultry feed constitutes ~70% of the total production cost, and incorporating GP into poultry diets offers a cheaper, sustainable solution for waste management and provides an AGP alternative to improve the gastrointestinal health and performance of chickens, reducing the production cost. Specific outcomes and impacts include:

Outcomes: 1. Demonstration of dietary GP to improve Cocciodiosis disease biomarkers, poultry growth and performance, **2.** Demonstration of nutritional and economic benefits of GP as a poultry feed input, and **3.** Development of industry guidelines for GP processing and best management practices for its use in poultry feed

Impacts: 1. More sustainable use of GP reduces disposal and environmental burdens, **2.** Using stilbenes from GP improves poultry health and productivity, **3.** GP utilization limits emergence of antibiotic resistant bacteria, and, **4.** Additional economic vitality of the grape and wine industry through sales of GP to feed producers.

Overall impact: Dietary Grape Pomace Mitigates Coccidiosis Symptoms



Results:

1. Complete analysis of the concentrations of bioactive compounds in Concord grape pomace (*Vitis Labrusca* L.), revealed significant concentrations of the following biocatives: Trans-Resveratrol, Cis-Resveratrol, Pterostilbene, Tannin, gallic acid, and Quercetin Dihydrate (Table 4).
2. Intestinal lesion score for *Eimeria* post dietary GP: significant reduction in disease phenotype (Figure 3).
3. Duodenal Gene Expression: Figure 4 illustrates the differences in gene expression of proteins related to BBM functionality, and tissue permeability. Results indicated that dietary GP significantly improved intestinal inflammation, and reduced intestinal leakiness, despite disease conditions.
4. Duodenal Morphometric Parameters (Figure 5): Dietary Grape Pomace (GP), at a level of 0.5%, and 0.75%, improved intestinal morphology, despite disease conditions. This indicated on increased cellular proliferation, and improved digestive and absorptive capacity.
5. Cell Mediated Immune Response (Figure 6): Dietary GP improved intestinal immune response, despite disease conditions.
6. MAPK/Nrf2/ARE pathways (Figure 7). The MAPK pathway (mitogen-activated protein kinase) transduces extracellular stress and inflammatory signals to regulate cell survival, proliferation, and immune responses. The Nrf2/ARE pathway is a central antioxidant defense system in which Nrf2

activates antioxidant response element (ARE) - driven genes to reduce oxidative stress, inflammation, and tissue damage, and it is often modulated by MAPK signaling.

7. Analysis of the Gut Bacterial Populations: microbial and metabolomics analyses of microbiome composition and function indicated on significant improvements in stool microbial profile and function. Specifically, significant increased in probiotics populations abundance (Figure 8A,B). This indicates on the prebiotic effects of dietary GP, and despite induced disease conditions.

Figure 3. Effect of dietary inclusion of grape pomace on intestinal lesion score for Eimeria acervulina (A), Eimeria maxima (B), and Eimeria tenella (C) at d 20 (6 DPI).
The lesion scores are represented as a percentage distribution of each score within each treatment group. NCC: non-challenged control without any dietary feed additives; CC: challenged control without any dietary feed additives and oral inoculation with 20 × doses of commercial live coccidiosis vaccine (Coccivac®-B52, Merck Animal Health, Omaha, NE); 0.5GP: CC with 0.5 % dietary inclusion of concord grape pomace; 0.75GP: CC with 0.75 % dietary inclusion of concord grape pomace. The lesion scores are represented as a percentage distribution of each score within each treatment group; DPI: days post-inoculation (n=12/treatment). Sharma et al., 2025.

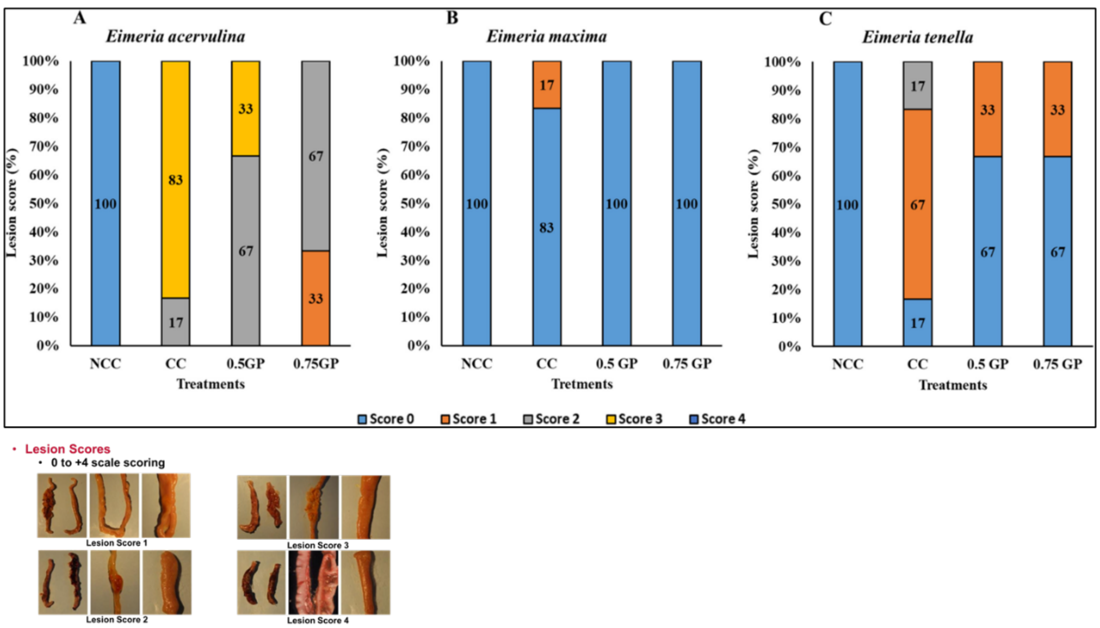


Figure 4. Intestinal barrier Function.
Effect of dietary inclusion of grape pomace on mRNA expression of tight junction integrity and intestinal barrier function at d 20 and d 26 (6 and 12 DPI). a-b values not sharing the same letters within the column significantly differ at P<0.05 (n=6/treatment/timepoint). Sharma et al., 2025.

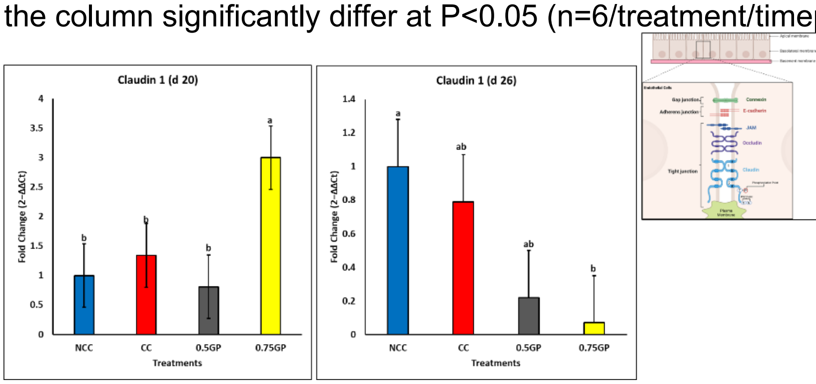


Figure 5. Effect of dietary grape pomace on intestinal histomorphology at d 26 (12 DPI). [a-c]values not sharing the same letters within the column significantly differ at P<0.05 (n=6/treatment/timepoint). Sharma et al., 2025.

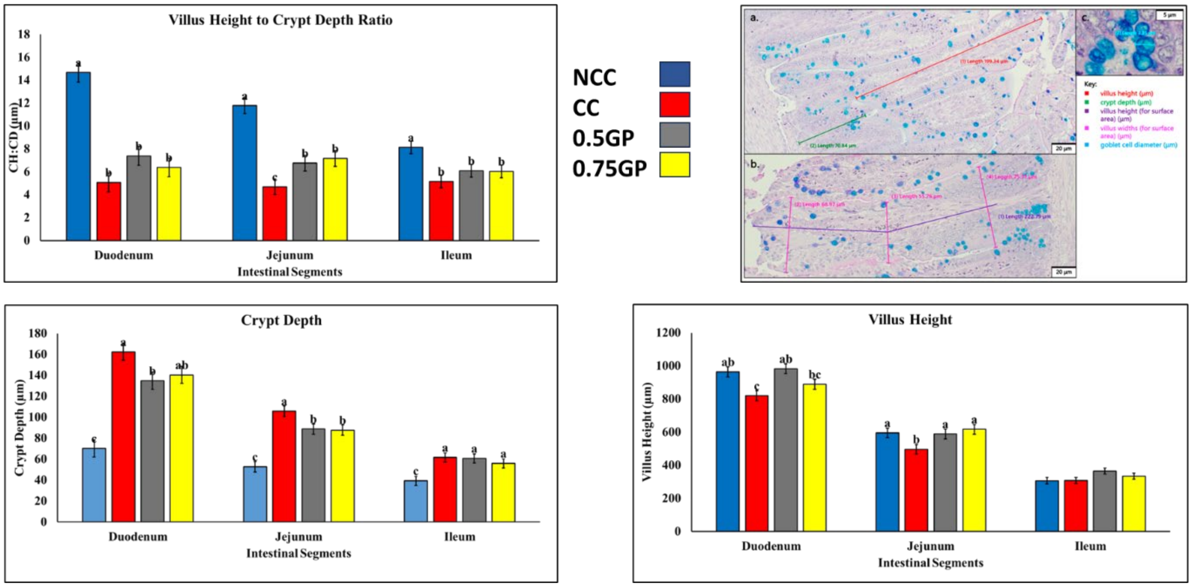


Figure 6. Cell Mediated Immune Response. Effect of dietary inclusion of grape pomace on T-cell differentiation at d 26 (12 DPI). [a-b]values not sharing the same letters within the column significantly differ at P<0.05 (n=6/treatment/timepoint). Sharma et al., 2025.

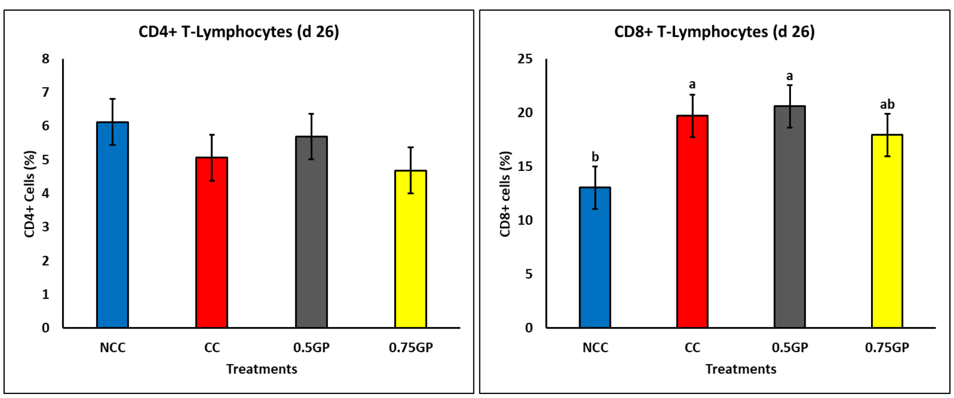


Figure 7. MAPK/Nrf2/ARE pathways. The MAPK pathway (mitogen-activated protein kinase) transduces extracellular stress and inflammatory signals to regulate cell survival, proliferation, and immune responses. The Nrf2/ARE pathway is a central antioxidant defense system in which Nrf2 activates antioxidant response element (ARE)–driven genes to reduce oxidative stress, inflammation, and tissue damage, and it is often modulated by MAPK signaling. Sharma et al., 2025.

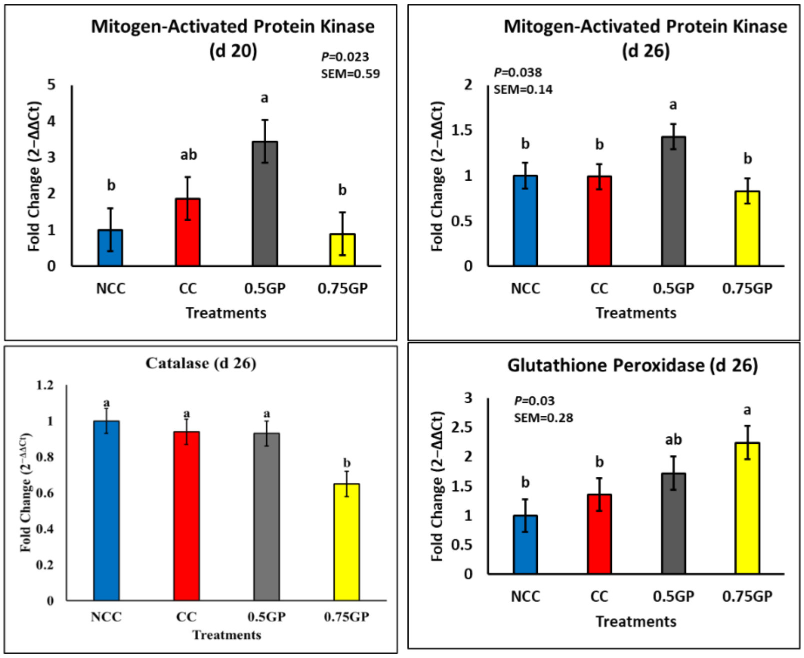
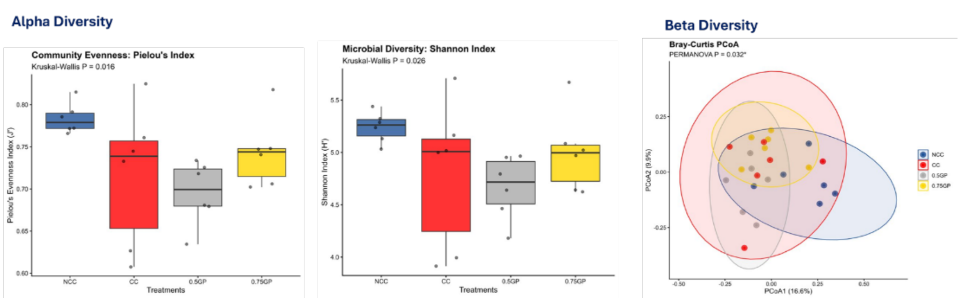
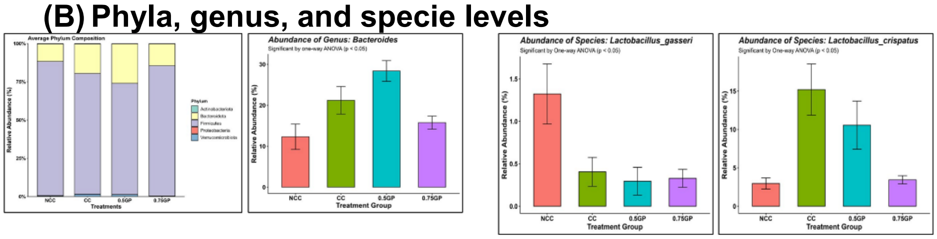


Figure 8. Microbial composition (intestinal content). Sharma et al., in preparation.

(A) Microbial richness and diversity.

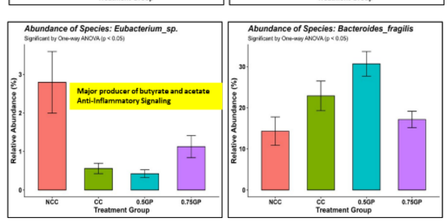


(B) Phyla, genus, and specie levels



Primary Physiological Functions *Bacteroides*

- **Polysaccharide Degradation:** *Bacteroides* are the "heavy lifters" of carbohydrate metabolism, breaking down complex plant cellulose and dietary fibers that the host cannot digest on its own.
- **Organic Acid Production:** Via fermentation, produce SCFAs (acetate, propionate), which help to maintain acidic intestinal environment to inhibit other pathogens.
- **Mucin-Modulation:** Can degrade the host's mucin-rich mucus layer. While beneficial for nutrient recycling, an overgrowth (CC, 0.5GP groups) can thin the protective mucus barrier, potentially increasing the risk of secondary infections like *Clostridium perfringens*.
- **Opportunistic Nature:** Generally commensal, can become "pathobionts" during high inflammation, potentially inducing or exacerbating enteritis when the intestinal barrier is compromised by *Eimeria*.



Technology Transfer Plan: Associated research in linked to US non-provisional patent Application No. 63/159,109 (filed March 10, 2022), Title: "Methods for improving poultry health" (Inventor: E. Tako), Cornell CTL Reference No: 9587-01-US.

Manuscripts (all published in 2025):

1. Dugan EM, Huang MY, Tako E. Evaluating the bioactive capacity of Concord grape (*Vitis labrusca*) pomace extract on skeletal muscle in a healthy and intestinally inflamed in-vivo model (*Gallus gallus*): a preliminary study, Journal of Functional Foods, Volume 133, 2025, 107005, doi: https://doi.org/10.1016/j.jff.2025.107005.
2. Huang MY, Dugan EM, Tako E. Concord grape (*Vitis labrusca* 'Concord') pomace extract impacts dextran sulfate sodium-induced inflammation in ovo (*Gallus gallus*), Journal of Functional Foods, Volume 129, 2025, 106840. Doi: https://doi.org/10.1016/j.jff.2025.106840.
3. Sharma MK, Dugan EM, Huang MY, Jackson C, Pataki MJ, Gracey PR, McGovern CJ, Tako E. Dietary grape pomace ameliorates intestinal damage and oxidative stress by modulating MAPK-Nrf2/ARE pathways in coccidia-challenged broilers (*Gallus gallus*). Poult Sci. 2025 Aug;104(8):105364. doi: 10.1016/j.psj.2025.105364. PMID: 40451073; PMCID: PMC12164180.

*NYWGF funding support was acknowledged in the manuscript.

Conferences (2025-6):

- Data was presented at the Poultry Science Association, 2025 Meeting (July 2025, Raleigh, NC).
- Data was presented at the IFT-FIRST 2025 meeting (July 2025, Chicago, IL).
- Data was presented at the Global symposium by Upcycled Food Foundation (The Value of Fruit Skins: Transforming Food Byproducts into Health Benefits, Sep 29-30, 2025)
- Data will be presented at the World Poultry Science Association, 2026 Meeting (July 2026, Toronto, ON).

SECTION 3: (The goal of this research is to benefit growers and producers across New York State. Result summaries will be shared on the NYWGF website and via email newsletters. To that end, this section should be brief and written in terms understandable for the average grower and producer, as well as consumers and trade interested in our industry.)

Project summary and objectives: Grapes are the most produced fruit by weight in the U.S., but processing leaves behind 20% as pomace, which poses environmental and economic challenges. Antibiotic growth promoters (AGPs) in poultry feed contribute to antibiotic resistance in the food system. This project proposes using grape pomace (GP) as a natural alternative to AGPs in broiler feed. Specifically, to treat coccidiosis, as this disease leads to $15B global losses/year. According to USDA, Coccidiosis costs to US poultry industry >$1B annually, including production losses (mortality, poor growth) and control costs (drugs, vaccines). The disease remains a top concern, driving the search for better control methods due to drug resistance. Our goal is to improve poultry growth, meat quality, and reduce feed costs and mortality by repurposing GP. A large-scale, dose-response, long-term trial will help develop practical guidelines for GP use, supporting vineyard sustainability and creating a new market for pomace.

Objectives: Repurpose grape pomace (GP) as a sustainable poultry feed additive to reduce feed costs, minimize environmental waste, and enhance broiler growth and to treat coccidiosis.

Specific Objectives:

- **Objective 1:** Evaluating the dietary inclusion of the Concord GP (*Vitis labrusca* L.) to mitigate the negative effect of coccidiosis, via large scale, long-term feeding trial in infected broilers (Coccidiosis) (dietary GP dose response of 0.5%, and 0.75%).
- **Objective 2:** Evaluating the potential of dietary Concord GP (*Vitis labrusca* L.) to reverse

negative effects of Coccidiosis on microbiome, and beneficial metabolites (SCFA), in infected broilers (Coccidiosis).

Significance: Coccidiosis is a major intestinal disease in poultry that leads to significant economic losses due to reduced growth performance, increased mortality, and the need for costly treatments. Current control strategies often rely on anticoccidial drugs, which can contribute to resistance and residue concerns. Demonstrating that GP can serve as a natural, cost-effective alternative to mitigate the impact of coccidiosis would not only improve animal health and productivity but also support the transition to more sustainable and antibiotic-free poultry production systems.

Importance of research to the NY wine industry: This research is important for the New York wine industry because it offers a sustainable solution for managing grape pomace, a major byproduct of winemaking. Currently, pomace disposal presents environmental and financial challenges for wineries, especially in regions like New York with high grape production. By converting this waste into a value-added poultry feed ingredient, the research supports circular agriculture, reducing waste and creating new economic opportunities for growers and producers. It also aligns with the industry's growing focus on sustainability and climate-resilient practices, helping New York wineries stay competitive and environmentally responsible. Ultimately, this innovation could enhance the overall sustainability profile and profitability of the state's wine industry.

Project Results/next steps:

- Complete analysis of the concentrations of bioactive compounds in Concord grape pomace (*Vitis Labrusca* L.), revealed significant concentrations of the following biocatives: Trans-Resveratrol, Cis-Resveratrol, Pterostilbene, Tannin, gallic acid, and Quercetin Dihydrate.
- Duodenal Morphometric Parameters: Dietary Grape Pomace (GP), at a level of 0.5%, and 0.75%, improved intestinal morphology, despite disease conditions. This indicated on increased cellular proliferation, and improved digestive and absorptive capacity.
- Duodenal Gene Expression: Results indicated that dietary GP significantly improved intestinal inflammation, and reduced intestinal leakiness, despite disease conditions.
- Analysis of the Gut Bacterial Populations: microbial and metabolomics analyses of microbiome composition and function indicated on significant improvements in stool microbial profile and function. Specifically, significant increased in probiotics populations abundance. This indicates on the prebiotic effects of dietary GP, and despite induced disease conditions.

Next steps: High value utilization of NY grape pomace: advancing poultry health and expanding market opportunities (laying hens)

Objective 1: Dietary Concord GP, with or without carbohydrases, improves broiler growth performance & meat quality through modulation of the gut microbiome.

Objective 2: Dietary Concord GP, with or without carbohydrases, enhances egg production & egg quality in laying hens via gut microbiome modulation.

Why It's Important: In laying hens, GP with or without carbohydrase supplementation presents a unique opportunity to sustain egg production & egg quality while enhancing gut health & immune resilience under antibiotic-free production systems. A significant industry in NYS (146M eggs monthly/1.8B annually) & US (350M commercial layers producing >100B eggs/annually, market valued >$20B)

- Industry need: AGP restrictions challenge poultry performance & gut health, while the juice & wine industry seeks sustainable, value-added uses for GP.
- Proposed solution: GP is a polyphenol-rich by-product with antimicrobial, antioxidant & anti-inflammatory.
- Mechanistic rationale: GP bioactives mimic AGP-like functions by reducing inflammation, modulating immune signaling & supporting the microbiome.

- Enhancing GP efficacy: Carbohydrase improve GP utilization (NSPs), and increase polyphenol bioavailability.
  Supporting attachment: Graphical abstract, Next steps