

# This Week's Citation Classic®

CC/NUMBER 38  
SEPTEMBER 22, 1986

Donaldson W E, Combs G F & Romoser G L. Studies on energy levels in poultry rations. 1. The effect of calorie-protein ratio of the ration on growth, nutrient utilization and body composition of chicks. *Poultry Sci.* 35:1100-5, 1956. [Poultry Department, University of Maryland. College Park, MD]

It was generally assumed that chickens ate primarily to satisfy their energy requirements. Although that principle generally holds, our work showed that chickens will overeat energy in order to overcome a protein inadequacy. [The *SCI*® indicates that this paper has been cited in over 140 publications.]

William E. Donaldson  
Department of Poultry Science  
North Carolina State University  
Raleigh, NC 27695-7608

July 17, 1986

This was my first published paper and was written while I was a graduate student studying under Gerald F. Combs. The paper's origin was linked to the fact that synthetic detergents began to replace soap after World War II. Animal fat, which was used in soap manufacture, became a surplus commodity. The animal feed industry was seen as a possible outlet for the fat, but addition of fat to poultry feeds was not without problems. Chief among these was a tendency for chickens fed added-fat diets to grow more slowly and to develop the habit of denuding each other's backs by feather pulling. Combs believed that these chickens were exhibiting signs of protein insufficiency related to raising the energy content of diets by fat addition. It became my task to test this hypothesis.

A series of 23 diets was formulated to contain varying levels of energy and protein and consequently a progression in the ratio of energy to dietary protein. We coined the term calorie-protein (C/P) ratio to help to define this progression, and the term has persisted.

A good deal of thought and discussion preceded the formulation of the diets. One such discussion stands out in my memory. There was a perceived need to add some type of inert filler to the various diets so that the ingredient amounts would total 100 percent. Combs favored the addition of sand while I argued

that the chickens would consume the same amounts of nutrients regardless of whether or not sand were present. Combs's reaction was, "You mean you want to add air to the diets?" The sand vs. air controversy took the better part of an afternoon to resolve and finally ended with Combs waving me out of his office with a smile and the words, "Add whatever you want." Luckily, the air addition worked, and we reported diet composition as weights rather than as percentages.

I believe that several reasons exist for the high citation frequency of this work. First, although there were many abstracts in the literature at the time that dealt with this subject, ours was the first full-length paper to appear. Second, since all of the protein-containing ingredients were added in constant proportion to one another, amino acid balance of each diet was constant. Thus, energy:protein effects were not confounded with protein quality, which could have caused difficulties of interpretation. Third, we made observations over a wide range of ratios and protein levels and did carcass analysis in addition to measuring body weight and energy and protein consumption. This broad approach may have extended the usefulness of our data.

Lynn Romoser, who died in 1985, had just finished his PhD under Mary Shorb at the University of Maryland when I arrived as a graduate student. He was a newly appointed faculty member whose participation in our discussions was invaluable, hence his inclusion as an author.

My research over the past 30 years has gone far afield from my feed-and-weigh approach of 1956. However, last year I published a paper<sup>1</sup> that utilized diets comparable in energy source and amino acid balance to selected diets from our cited paper. Modern chickens grow more rapidly and are fatter than their ancestors, but it was gratifying to see that the same relationships among C/P ratio, body weight, and body fat content were apparent still.

Finally, I wonder what would have happened had I known in 1956 that my first paper was destined to become a *Citation Classic*. Would I have quit while I was ahead?

1. Donaldson W E. Lipogenesis and body fat in chicks: effects of calorie-protein ratio and dietary fat. *Poultry Sci.* 64:1199-204, 1984.