

GROWTH EXPERIMENTS

Background and justification:

Energy and protein are primary nutritional requirements of all classes of animals and types of production, including growing ruminants and quail. These requirements must be met (energy first, protein second) before requirements for other nutrients (minerals and vitamins) are addressed. An important principle, which we will study in this trial, is that an animal's ability to productively use protein may be limited by its energy supply and vice versa.

The amount of energy and protein made available to the animal for its metabolism and growth is determined by the amount and quality of the feed eaten. If feed is offered ad libitum (always available), these two factors may be related i.e. amount eaten may be determined at least partly by feed quality. In these trials we will examine the separate and combined influences of energy and protein level and quality in the ration on voluntary feed intake, as well as on growth performance (average daily gain). Together, these two measurements can be used to calculate efficiency of feed utilization, commonly called feed efficiency, as:

$$\text{Feed efficiency} = \frac{\text{Average daily gain (g)}}{\text{Daily dry matter intake (g)}}$$

This is a very important measurement because of the high cost of feed. It is also a useful index of biological efficiency because high values (high efficiency) are associated with more lean and less fat growth. (Note: You may sometimes see food efficiency expressed as feed:gain, the reciprocal of the above formula. This is the traditional way of expressing feed efficiency, but it is falling out of favor.)

The energy value of ruminant feeds is greatly affected by their fiber content because this is inversely related to digestibility (the fraction of feed eaten which is not excreted as feces). Roughages generally have higher fiber content and lower digestibility. Conversely, concentrates are lower in fiber and higher in more digestible constituents such as starch. Thus, the energy value of a mixed ration can be increased by substituting concentrates, such as corn, for roughages, such as corn silage or hay. In this experiment, the main roughage source will be grass hay and the main concentrate source will be ground corn.

The protein value of feeds is affected by amount, form and quality of protein. Form refers mainly to the ease with which dietary protein is digested by rumen fermentation and is influenced by solubility. Quality refers to amino acid composition and particularly, content of essential amino acids, of particular importance to our quail.

For optimal performance in high-producing ruminants there should be enough soluble, readily-fermentable protein to support microbial growth and fermentation in the rumen, plus a source of less fermentable protein which can pass directly to the abomasum and

small intestine for normal proteolytic digestion and absorption. The latter is often called "rumen undegradable", "bypass" or "escape" protein. Balancing these components represents one of the biggest challenges in applied ruminant nutrition. For avian species quantity and quality will be important.

The interdependence of dietary energy and protein is manifested in several different ways. A low energy value will impair efficiency of protein utilization at several levels. Firstly, insufficient fermentable energy will limit the rate of microbial growth and ability to synthesize microbial protein, regardless of level of dietary protein. This, in turn, will limit rate of fermentation and overall ration digestibility, rate of passage and voluntary intake. Secondly, this restriction of microbial protein synthesis leads to increased production of ruminal ammonia which is absorbed, converted to urea in the liver and excreted by the kidneys. This represents a net loss of nitrogen to the animal. Thirdly, if the animal is deficient in absorbed non-protein energy (such as glucose or volatile fatty acids) it will use absorbed amino acids for energy, at the expense of tissue protein synthesis. Conversely, inadequate level or quality of protein can limit the efficient use of energy by rumen microorganisms (in the ruminant) and body tissues (in ruminant and non-ruminant species). Thus, an optimal ratio of dietary protein to energy is essential for optimal rates of microbial protein synthesis and rumen fermentation, as well as for efficient use of absorbed nutrients by tissues such as growing muscle or the lactating mammary gland.

Specific objective of quail trial:

1. Demonstrate effect of dietary protein level and genetic strain on voluntary feed intake, average daily gain, and efficiency of feed utilization (gain:feed ratio) in 1-3 week old growing quail.
2. Demonstrate the effect of dietary protein level and genetic strain on onset of puberty and egg production (5-7 wk old).

Materials and methods:

Animals. Japanese quail will be obtained from two separate genetic strains. They will be randomly allocated to one of four dietary treatments and housed in groups of 20 individuals in each group on the same treatment in pens in LARTU.

Diets. Diets are 16%, 21%, 26% and 31% CP.

Experimental procedure.

Quail will be fed, watered and examined for well-being each day including weekends, at 8:00-8:30 a.m., under the supervision of a TA. Students must sign up for these duties the week before the trial starts (week of September 3). **It is mandatory for rostered students to perform these vital tasks.** Failure to do so may not only affect the success of the experiment, but may result in animals being deprived of feed and water, which is unacceptable. **There is no make-up for missed chores.** Feeding involves careful weighing and recording of feed. Fresh water must be supplied each day.

Part 1 Measurements. Absolute weight gain, average daily gain, average daily feed intake and gain to feed ratio will be calculated from primary measurements of liveweight and feed intake.

Part 2 Measurements. The following measurements in addition to daily feed intake are as follows: - onset of puberty as determined by when they begin to lay eggs, and 50% lay.

Calculations and statistics. Mean values will be calculated for the quail in each treatment/pen group, for these variables: liveweight at beginning and end of trial (g), cumulative liveweight gain (g), average daily gain (g/d), average daily feed intake (g DM/d), feed to gain ratio. You will be given more specific instructions about calculations and data presentation.

Report:

Students will be placed in groups of four. Each group is to write a report containing a Results and a Discussion section, as if they had single-handedly conducted the whole experiment. Results should be concisely summarized in tables and where appropriate, graphs with text description of treatment effects. The Discussion should not be simply a reiteration of findings, but should attempt to relate results to nutritional principles discussed in lectures and labs, and described in recommended textbooks. Reports must be submitted during lab the week of Nov. 5. In addition, each group will be expected to present a 10 minute oral presentation of their results.

Specific objectives of lamb trial:

1. Demonstrate effect of dietary energy level on voluntary feed intake, average daily gain, and efficiency of feed utilization (gain:feed ratio) in growing lambs.
2. Explain performance responses in terms of measured effects of dietary treatments on apparent digestibility of dry matter and on plasma concentration of selected metabolites.

Materials and methods:

Animals. Sixteen weaned lambs (18 males and 8 females; 3 mo, 25 kg) will be obtained from the Teaching and Research Sheep Production Unit. They will be ranked according to liveweight, semi-randomly allocated to one of two dietary treatments and housed in groups of four (individuals in each group on the same treatment) in floor pens in the Horse Teaching Barn.

Diets. Groups of lambs will be adjusted to experimental diets over a 10 day period, then fed ad libitum for 4 wk. Diet formulations will be made available.

Experimental procedure.

During the week beginning September 10, and weekly thereafter for the next 4 wk, lambs will be weighed and blood-sampled (external jugular venepuncture, 5 ml). Lambs will be allocated to each of the 5 lab groups (M, T, W, R, F) and each week weighing and sampling and blood processing will be done by a subgroup of 6-8 students during the normal lab class. Times will be arranged by your TA.

Lambs will be fed, watered and examined for well-being each day including weekends, at 8:00-8:30 a.m., under the supervision of a TA. Students must sign up for these duties the week before the trial starts (week of September 3). **It is mandatory for rostered students to perform these vital tasks.** Failure to do so may not only affect the success of the experiment, but may result in animals being deprived of feed and water, which is unacceptable. **There is no make-up for missed lamb chores.** Feeding involves careful weighing and recording of feed refusals (orts) from the previous 24 h period, and weighing of an amount of fresh feed estimated to exceed the lambs's ad libitum intake. (You can guess this from previous feeding performance.) Fresh water must be supplied each day.

During the week of October 9, four male lambs on each treatment will be placed in metabolism cages for daily measurement of individual feed intake and feces output, as described in Section 1.

Measurements. Composition of diets will be measured by the DHI Forage Testing Laboratory. Absolute weight gain, average daily gain, average daily feed intake and feed to gain ratio will be calculated from primary measurements of liveweight and feed

intake. Apparent digestibility of dry matter will be calculated as described in Section 1. Plasma urea nitrogen (PUN) and glucose concentrations will be measured by enzymatic, colorimetric assays detailed in Laboratory 9: Lamb Growth Trial Lab Analyses. **NOTE: It is extremely important in this as in all chemical assays to follow instructions exactly. If you are in any doubt, consult your TA.**

Calculations and statistics. Mean values will be calculated for the lambs in each treatment group, for these variables: liveweight at beginning and end of trial (kg), cumulative liveweight gain (kg), average daily gain (g/d), average daily feed intake (g DM/d), feed to gain ratio, weekly PUN and plasma glucose concentrations. You will be given more specific instructions about calculations and data presentation during the lab class the week of November 5.

Report:

Each student is to write a report containing a Results and a Discussion section, as if (s)he had singlehandedly conducted the whole experiment. Results should be concisely summarized in tables and where appropriate, graphs with text description of treatment effects. The Discussion should not be simply a reiteration of findings, but should attempt to relate results to nutritional principles discussed in lectures and labs, and described in recommended textbooks. Reports must be submitted no later than 5:00 p.m., Monday, November 26.