



## Substrate toxicity and inhibition

**Anti-nutritive factors.** Some feeds, such as forage legumes and cottonseed, contain phenols, alkaloids and saponins that have negative biological effects on microbes and reduce microbial growth in rumen. Gas Endeavour's high repeatability, low detection limit and independence of external factors like room temperature and pressure, ensure the measurement of anti-nutritive levels that syringes and barometric instruments are not able to detect.

**Effects of added fat on feed degradation.** Fats are common supplements used in the diets of lactating dairy cows. Gas Endeavour's high accuracy and repeatability ensure that any difference between the fat-added sample and the control sample is exclusively caused by the effect of fat addition, and not by instrumental uncertainties (e.g. variations of the room temperature and pressure when using syringes, calibration offsets, weak batteries and thermal drift when using pressure sensors).

**Rumen modifiers.** Monasin, yeast and yeast fermentation by-products are added often to the diet in order to modify the bacterial populations in the rumen. Gas Endeavour makes easy to study their effects, by simply incubating feeds in the presence or absence of such compounds. The data from such tests are crucial for optimizing milk production costs and overall productivity in commercial dairy farms.

**Feed associative effects.** Rations are mixtures of individual feeds, with a multitude of possible combinations. Because of positive associative effects on *in vitro* GP, it is not correct to sum the individual ME of the ration's components. Gas Endeavour allows performing triplicate tests on five different rations at a time.

**Monitoring rumen microbial change.** In addition to rates and extents of digestion, Gas Endeavour can be used to study substrate-related factors that influence microbial populations in the rumen. This enables manipulation of rumen microflora to increase the utilization of feeds through degradation of fibre and lignin, increasing the efficiency of nitrogen utilization or allowing the degradation of antinutritional and toxic components of feeds.

**Nutrient synchronization.** Carbohydrate and nitrogen sources must be available simultaneously in order to maximize microbial growth. Ruminal ammonia concentrations can be influenced by the degradation rates of carbohydrates and nitrogen-containing compounds. Gas Endeavour offers an opportunity to easily study microbial requirements for nitrogen and carbohydrate in order to enable efficient fermentative activity and accumulation in the rumen.

**Plant breeding, biotechnology.** Several forage and cereal crops have been genetically modified to increase yield, or produce chemical constituents normally deficient in a particular plant. Forage plants are selected for rapid fibre digestibility. Plants have also been genetically engineered to produce human lysozyme, but it is unclear what effect lysozyme has on microbes in the rumen. Although many genetically engineered plants are intended for human consumption, their by-products will be fed to animals as a means of disposal. Gas Endeavour, having 15 reactors and measurement channels, allows to evaluate large numbers of samples, in order to select in short times those with the highest feeding values.

**Environmental degradation.** More than half of the nutrients consumed by ruminants leave the animal unutilized and undigested, and are excreted in faeces, urine and gases. This increases animal production costs as well as environmental impacts, by contaminating surface- and groundwater and contributing to air pollution. Gas Endeavour allows the quick and easy selection of the rations featuring the highest efficiency of feed utilization, which in turn reduces the amount of unutilized nutrients leaving the animal hence, lower feed costs and environmental burden.

## Conclusions

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Gas Endeavour is able to produce in short time large amounts of accurate (1% error margin) and repeatable (3% < C.V. < 8%) GP data from *in vitro* tests, providing scientists with easily analysable Excel tables for their research, and commercial dairies with the most reliable information to optimize the ration's composition, and hence the feed cost and milk productivity.