Where does Alakalage fit?

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Many cereal crops have been sown this year for to provide grazing and to then be taken off as a whole-crop (grain heads and straw) silage, hay, and possibly some as Alkalage. Alkalage is a relatively new innovation and alternative system in Australia for storing whole-crop forage cereals.

What is alkalage?
Alkalage is produced by preserving whole-crop (grain + stem + leaves) cereals using a process of ammoniation. This is achieved by spreading a specific additive, HOME'N'DRY®, developed for this purpose. This is a manufactured pellet containing both urea and urease which ensures that the production of ammonia will occur over a wide range of dry matter (DM) contents. "Alkalage" is a patented name in the UK but, in Australia, simply refers to an ammoniated whole-crop cereal crop by adding the HOME'N'DRY® additive.

The sole additive is now produced under licence in West Australia (08 9924 1145) and is now available in south eastern Australia (0427 715 939). A few crops were put in as alkalage last season and many more will be made this season.

The fermentation process that occurs when whole-crop cereal is ensiled will result in approximately 10% loss of DM as well as some nutritional value. However, when preserved as alkalage storage losses are minimal once stored. During harvest, losses will also be negligible if a forage harvester fitted with a direct cutting front is used for harvesting the drier whole-crop for alkalage production.

Where the ideal equipment is not available and the crop must be mown, possibly raked if a windrower is not available, and harvested with a pick-up front, losses will be substantially higher. These losses will be mainly the grain, the most nutritious part of the plant. Losses of about 400 kg/ha grain were estimated in 2005 at DemoDairy when a triticale crop was harvested without a direct cutting front. The grain yield was estimated to be about 3000 kg/ha so this represented a 13% loss of highly nutritious feed!

Why not just add urea while building the stack?
Preservation by ammoniation was attempted in the past in the UK, Ireland and Europe, by spreading urea in layers in the stack as the whole-crop was harvested. Urease, plant enzymes, in the presence of plant moisture, then reacted with the urea allowing ammonia gas to be released. This ammonia then permeated throughout the stack and prevented mould and yeast growth and aerobic deterioration, effectively raising the pH level to preserve the crop in alkaline environment. Ensiling is the complete opposite where the fermentation or "pickling" process causes the pH to be decreased, i.e. becomes more acidic.

However, reliability of the urea treatment only worked in a narrow DM range, 50 – 55% DM. If made too wet, the whole-crop would be trying to ferment (become acidic) but the ammonia from the urea addition would be trying to preserve the crop by an alkaline process, usually resulting in compost! However, if the material is too dry, lack of moisture would often reduce plant urease effectiveness often resulting in a very mouldy product, often also leading to compost.

As a result of these problems but realising that there were great benefits (higher yield, higher nutritive value) to be gained by preserving whole-crop at higher DM contents, Alkalage was developed.

When to cut for alkalage?
Alkalage is produced in the DM range of 65 - 85% DM, or less than 35% grain moisture by adding HOME'N'DRY®. IN this DM range, the cereal grain will be at the hard dough stage, with grain fill completed and the crop will be near its maximum nutritional value.

If alkalage is attempted under about 65% DM, i.e. wetter, then the forage may try to ferment, thereby reducing the pH, not increasing it as required to produce alkalage. Similarly crops cut too early will contain too much green material i.e. be too wet, and those containing a lot of green grass or weeds may also encounter the above problem. Conversely, crops cut over about 85% DM will not contain enough moisture to activate even the additive.

Visibly, the crop will be about 66 – 70% DM when it is yellow-brown and traces of green at the nodes (joints), some heads will be bending over and the grain cannot be penetrated with a thumbnail. At 71 – 85% DM, all the plant will be yellow brown, the heads will be bent over and the grains will be very hard. Be aware that different species and cultivars may vary slightly in physical characteristics to these just mentioned.

How to harvest alkalage?
The standing crop is very dry at this stage so should, ideally, be harvested using a precision chop harvester fitted with a specific direct cutting front to minimise grain loss during harvest (See figure 1). Chopping the whole-crop very short using a precision chop harvester is essential to ensure reasonable compaction in the stack/bunker. Compaction in the stack can be less dense than that required for cereal silage to allow greater movement of the ammonia gas throughout the stack.

Figure 1. Direct harvesting whole-crop cereal for alkalage

The harvester should also be fitted with a specific cereal grain cracker or “processor” to ensure that the grain is cracked open. This allows the permeating ammonia access to it and increases its digestibility (See Table 1). The maize cracker already integrated into many harvesters is not as efficient as the specifically designed whole-grain primary processor.

Development has resulted in specific roller designs with specific differential rotation speeds, very close clearances and, to avoid blockages, defined curvature and secondary concave positioning. Research has shown the cereal grain utilisation is about 97% when a grain cracker is used compared to about 82% when not used. Attempts to harvest without a processor will lead to crop of lower nutritive value with many grains passing through animals undigested.

Can alkalage be made with balers?

Baling of whole-crop as alkalage is not recommended as the operations (mowing, raking and baling itself) required to bale whole-crop would result in substantial loss of grain (6-10% measured in early studies in the UK). The rolling mechanism in some balers can cause even higher losses (up to 30%). Also incorporating the pellets during baling would be very difficult requiring large amounts to be carried on the baler, or regular stopping to refill.

Whole-crop is normally cut at ~10 cm above ground level to include the whole plant (stem, leaves and grain head) resulting in the lower end of the nutritive value range. Higher nutritive value can be achieved by cutting higher (see Table 1), even as high as just below the grain head level, called earlage, resulting in the highest quality product. This UK research used a maize cracker on whole-crop wheat, shows the effect of cutting height and processing on the final energy value. Obviously cost of harvest, machinery capability, management of residual straw, end use of the product, etc. must all be weighed up for a proper economical and nutritional analysis.

Table 1. Effect of cutting height and processing on the energy of whole-crop wheat alkalage

Stubble Height (cm)	Energy (Mega joules of metabolisable energy/kg DM)	
	Without processing	With processing
18	9.6	10.5
37	10.2	11.3

More recent UK research has reported that alkalage gave similar animal performance to that when fed maize. Although no alkalage feeding trials have been conducted in Australia to date, UK and Europe research suggests that it may have a place in some situations in Australian diets.

However, in the whole-crop situation, the heavier the ear (grain head) compared to the stem and few remaining leaves, the higher the nutritive value of the end product. Unfortunately, unlike UK and European cereal species which can have over 50% of their weight in the ear, most crops in Australia have lower grain to stem ratios, i.e. lower nutritive value.

A major advantage of alkalage is the wide window of opportunity for harvesting, from about 65% DM to 85% DM. This DM range may translate to a harvest period of over 30 days, as long as lodging (plants collapsing) was not a risk. Alkalage can even be produced from slightly damp or dew affected crops without significantly reducing its nutritive value. These conditions may even reduce the loss of the highly nutritious flour and chaff, especially in very ripe (extremely dry) crops.

How is alkalage stored?
Usually best stored in pits or bunkers, preferably with concrete walls or soil sides to prevent the material spreading while rolling. Much safer too!

A super spreader is normally used to spread the HOME'N'DRY® pellets over the stack before a new layer of whole-crop is delivered (See Figure 2). Each layer of material must be less than about 30cm depth to allow thorough permeation of the gas throughout the stack.

Additive application rate is 30 - 40 kg/tonne of fresh weight (3 – 4%) and will react within about 20 minutes of contact with the forage, releasing the urease. Once this occurs, the released ammonia gas then permeates throughout the material, effectively preserving the whole-crop by preventing nearly all mould and yeast growth.

Figure 2. Spreading additive on the stack

The stack must still be sealed as you would a silage stack to retain the ammonia gas. Feed out should not occur for approximately 4 - 6 weeks to allow for full effectiveness of the ammoniation treatment. No effluent will be produced. Another major advantage of alkalage is that birds and vermin are deterred whereas whole-crop silage tends to "attract" them.

What is the effect of ammoniation on nutritive value?
Ammoniation of cereals will generally result in an increase of crude protein of 4 - 5%, possibly a slight rise in energy due to an increase in the digestibility of the fibre.

The alkalages produced in Table 1 were fed to milking cows with the following outcomes.

- The extra energy did not increase milk yield or milk components (protein %, milk fat %).
- The extra energy did not result in increased condition score.
- Processing reduced intakes.

Bottom line: The feed conversion improved slightly as the cows ate less for the same performance.

In other research, alkalage diets performed slightly below that of maize and similarly to fermented whole-crop silage. Obviously costs and losses in harvesting and storage must also be taken into account when looking at any research results. Australian research comparing alkalage with our wilted silages, maize, etc. under Australian conditions, and viewed as a whole system, would be highly desirable to support the likely benefits that alkalage can offer.