



Summary of Benefits Associated with
Bruce Agra Dehy
Unique Processing Technology



INTRODUCTION

Bruce Agra Dehy (BAD) produces the Bio-Cube® line of superior quality forage products as a result of its unique technology. The primary objective of this document is to qualify and quantify the benefits of indirect-heat, low-temperature dehydration versus sun-cured and conventional directheat, high-temperature dehydration.

Alfalfa has always been considered the queen of forages and rightly so. However, we at BAD believe there is always room for improvement. That is the theory behind our blended products such as Alfamaize® and Alfa-Timothy™ . By blending alfalfa with other forages we can create products of distinct nutritional composition that better complement the various developmental stages and physical activities of the horse.

Due to the unique process adopted by our organization, BAD possesses many advantages over its competitors. Due to low temperature indirect fluid bed drying equipment, BAD can dehydrate heat sensitive ingredients such as an immature whole corn plant that cannot be easily dried in conventional drum dryers. With two production lines, we can simultaneously process two ingredients while maintaining complete and total control of the product mixture. These two features enable BAD to produce nutritionally superior blended forage products, such as Alfamaize®.



SUPERIOR NUTRIENT COMPOSITION

As stated by P.G. Gibbs and G.D. Potter (1992) from Texas A&M, (report enclosed) Alfamaize® contains 2.85 Mcal/kg of digestible energy (DE). The NRC Nutrient Requirements of Horses (1989) reports that alfalfa contains from 1.97 to 2.24 Mcal/kg of DE. Alfamaize®, therefore, contains on average a 30% increase in energy over Alfalfa.

Alfamaize® is a unique forage product providing both energy and protein at a rate that perfectly complements the demands of the equine athlete. The benefits of alfalfa (which are deficient in a whole corn plant), coupled with the benefits of a whole corn plant (which are deficient in alfalfa) act in synergy, to create a nutritionally superior product. This explains why Alfamaize® does nutritionally better than the sum of its individual ingredients.

Alfa-Timothy™ is a natural blend of premium alfalfa and early bloom timothy. Alfalfa-timothy is a classic, well-established mix which is accepted by horsemen and horses alike. Alfa-Timothy™, sells on its name alone, and its legacy is nutritionally sound. In comparison to Alfalfa, Alfa-Timothy™ contains more suitable protein content for horses. Furthermore, Alfamaize® and Alfa-Timothy™ contain a more appropriate calcium to phosphorus ratio than most forage sources, including Alfalfa.

The benefits attained from dehydration as opposed to sun-curing are: optimum nutrient retention, maximum vitamin preservation, phytosanitation, utmost feed safety, maximum colour preservation, freshness, palatability and is virtually mould and dust free. From what we know, concerning human nutrition, it is only logical to conclude that low temperature dehydration is more beneficial than high temperature dehydration. It is to be noted that the vast majority of alfalfa cubes on the market are sun-cured. BAD, however, uses only indirect-heat, low-temperature dehydrated alfalfa to make its cubes; and we shall prove the added value of our process over direct heat, high temperature dehydration and sun-curing.



OPTIMUM NUTRIENT RETENTION

BAD takes pride in its ability to process premium quality alfalfa in a way that insures maximum nutrient retention. Nutrient losses in sun-curing hay can range from 20% to 40% and even exceed 70%, if harvested in unfavourable weather. The amount of harvest and storage losses in making conventional hay is estimated to be greater than any other crop grown. The BAD harvesting and processing system minimizes nutrient losses that can be attributed to the following conditions: respiration, weather, mechanical and storage.

RESPIRATION

Cells in plants continue to live and respire after cutting until the plant moisture reaches 40%. This process of respiration and oxidation uses soluble plant fractions [dry matter] such as sugars and starches, and oxidizes important nutrients such as Beta Carotene (Vitamin A). Consequently, the sooner the plant moisture reaches 40%, the greater the nutrient retention.

To ensure greater nutrient retention, BAD harvests at high moisture and processes immediately. However, for sun-cured products this loss can account for 2% - 8% of dry matter, and under poor drying conditions this may increase to 16%. According to the law, feed manufacturers need only guarantee Crude Protein, Crude Fat, and Crude Fibre (not the nutrients directly involved in respiration losses). Although these losses will not be declared in the guarantee analysis on the bag, they will affect feed performance (i.e. feed value).

WEATHER

A significant factor in making quality sun-cured products is the need for good weather conditions. The table below demonstrates the effect of rain on dry matter loss in alfalfa.

	No Rain respiration loss	Inches of Rain		
		1	1.5	2.5
Dry matter % loss	9.6	10.2	46.6	54.4

It usually requires three to four days to field dry hay and, during this period (2), chances of rain fall are greater than 50%. Rain generally reduces the level of available carbohydrates or energy through leaching. Although rainfall does not affect protein by leaching, it can decrease protein levels through leaf loss and shattering. Leaching routinely increases Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF) levels with minimal changes in protein (2). As mentioned above during respiration losses, crude protein is a guaranteed nutrient on the bag, but not the energy (or TDN). All in all, equine performance is more dependent on energy than protein. BAD, on the other hand, is not dependent on continuous good weather as it artificially dries its ingredients.



MECHANICAL

The two major factors contributing to mechanical losses in sun-cured products are the moisture content of the alfalfa, at harvest, and the type of baler and raking equipment. Losses from conventional small rectangular balers range from 3-8% . While large round baler losses can reach as high as 15% . Raking losses can range from 15-25%.

Mechanical losses result from leaf shattering. Alfalfa leaves dry three to five times faster than stems. In alfalfa, leaf loss is crucial; leaves contain 50% of the plant's weight, but contain 70% of the protein, 90% of the carotene or vitamins, and more than 65% of the digestible energy.

Again only one of these losses, crude protein, is stated on the guaranteed analysis. BAD's method of harvesting alfalfa, at elevated moisture levels, ensures mechanical losses become negligible; leaf shattering does not occur at high moisture.

STORAGE

If hay, with less than 20% moisture, is stored inside it will continue to lose approximately 5-10% of its dry matter. To bale hay at greater than 20% moisture significantly increases storage loss, due to microbial growth and the resultant heating (not to mention combustion). Since BAD does not store any of its raw ingredients or finished products at greater than 10% moisture, storage losses are non-existent.

SUMMARY

The table below summarizes the benefits of BAD's cubes over hay harvested and stored at recommended moisture levels.

	Conditions	BAD's % Gained
Harvest	Respiration	2-16
	Mechanical	8-45
	Weather	10-55
Storage	Inside	5-10
	Outside	8-29

Sun-cured cubes will undergo varying degrees of these four losses. *These losses are not apparent from the guaranteed analysis on the bag.* However, they will determine the total feed value of the products. In summary, cubes produced from dehydrated alfalfa will easily contain 20 - 40% more nutritive value than cubes produced from sun-cured alfalfa of comparable maturity.



MAXIMUM VITAMIN E PRESERVATION

Dehydration is known to preserve all fat soluble vitamins, Vitamin E being the most relevant in the equine market. BAD tested for Vitamin E on product that had been aged for one year. It has been concluded that our dehydrated alfalfa still contained, on average, 72.6 mg/kg of Vitamin E. The NRC reports only 23.5 and 10 mg/kg of Vitamin E for early-bloom and mid-bloom sun-cured alfalfa, respectively. Therefore, on average our products contain an additional 62.6 mg/kg of Vitamin E over sun-cured alfalfa. BAD continues to investigate the retention level of vitamins in our low temperature dehydrated products and the affects of direct heat, high temperature dehydration on vitamin integrity.

PHYTOSANITATION

Phytosanitation pertains to the level of plant insects and pathogens within a product. In other words, phytosanitation controls the spread of plant insects and diseases to the importing area's flora.

The affects of dehydration on phytosanitation are obvious by Gary Koivisto comment, "It is generally recognized that dehydrated cubes and pellets are prepared in such a fashion that the potential for insect pest spread by the movement of this product is remote". There are two major pests restricting the export of alfalfa, the Hessian Fly and Verticillium wilt.

In Canada, the Hessian Fly is considered a minor pest of wheat and barley, and seldom does it cause noticeable damage. The Japanese concern is its unknown potential to cause harm to its rice crops. Dr. Sokhansanj studied the use of heat to destroy the Hessian Fly. He found that 60°C for three minutes is 100% effective in killing Hessian Flies. BAD's drying condition clearly exceeds this requirement in both time and temperature. For other conventional dehydrators, proving that rotary drum driers reach 60°C is not difficult; what is left to prove, is that the residence time for chopped hay in a rotary drum drier is at least three minutes.

Verticillium wilt is a fungus that attacks the vascular tissue of alfalfa stems, impeding the flow of water to the root. Quick exposure to temperatures greater than 68°C resulted in complete destruction of the spores and the mycelial bodies of the fungus. Research suggests that heat treatment with sufficient retention time (as at BAD) is undoubtedly the safest and surest method of disinfecting forages. Our price reflects the added benefit of this heat treatment which produces a contaminant free product, suitable for export. Feed safety deals with the level of toxins or bacterial contamination within a product. In other words, feed safety safeguards animals against feed contamination or poisoning.

Minimum research has been conducted regarding the optimum retention time and minimum temperature for forages, to maximize sanitization. We do know from human nutritional studies that heat of 100°C destroys bacteria. In feed manufacturing, pelleting and extrusion are useful tools for controlling Salmonellae poisoning because temperatures ranging from 80 to 132°C are maintained for 20 to 240 seconds during the process. BAD's drying conditions easily exceed the temperatures required to destroy microbes, resulting in microbial free products.



phytosanitation cont'd

Heat treatment becomes less clear with respect to toxins. Toxins are toxic fungal metabolites. If a rare instance of fungal growth occurs before processing, the heat of our driers would kill the fungus. It is less clear whether or not heat will destroy the toxins produced by these strains of fungus. BAD is confident our drying conditions will deactivate most, if not all, toxins. Research is in progress to corroborate this claim.

Some varieties of alfalfa contain significant levels of polyphenolic compounds known as tannin. Tannins inhibit protein digestion as well as being toxic to vital organs. Temperatures in excess of 90°C are believed to deactivate tannins.

Although our objective is to cultivate pure stands of alfalfa, it is unrealistic to contend that all fields are absolutely weed-free. Furthermore, some of these weeds contain toxins such as cardiac glycosides, thiaminase, pyrrolizidine alkaloids, and many more. Although continuous exposure to heat deactivates some of these toxins, BAD ensures that each field is inspected for the presence of toxic weeds prior to cutting, and is approved for harvesting only when toxic weeds are not a risk. BAD continues to research the heat sensitivity of all plant toxins.

Equine (EPM) is a neurological disease of horses caused by the protozoal parasite, *Sarcocystis neurona*. Thirty years ago this disease was rare and sporadic, but it is now on the rise. The clinical signs of this disease can be subtle and progress slowly or not at all, which means that many horses may never be diagnosed or most often misdiagnosed. Research efforts have implicated the opossum as the likely host of the protozoan parasite. The *Sarcocystis* spp. are naturally occurring parasites within birds. Opossums eat infected bird carcasses and the opossums' faeces in turn contaminate pastures, grains and hay. Opossums often seek refuge in hay barns.

Horses then eat the contaminated feed. BAD has three distinctions that safeguard against this devastating parasite. First, BAD is in a region with a sparse opossum population. Secondly, we do not store hay in barns like most sun-cured cube producers. Finally, even if infestation was a possibility, our dehydrating conditions would destroy the parasite.

Food safety is a genuine and growing concern in the horse industry, especially since food poisoning or contamination is most often misdiagnosed. BAD's heat treatment of forages definitely kills all microbial growth and, we believe, deactivates numerous toxins and anti-nutritional factors.

Consequently, considering the cost and suffering associated with these afflictions, BAD's unique forage purification process is invaluable to the horse owner and, as such, is reflected in our higher pricing.



MAXIMUM COLOUR

Colour is the consumer's first impression of quality - colour sells! Industry acknowledges that faster drying retains better green colour. The reason for better colour preservation through accelerated drying may be the retarded loss of chlorophyll to pheophytin when the moisture of the material is reduced faster. This effect is maintained up to 175°C and after that the colour declines due to the charring and burning of the material. (4) BAD's technology and quality procedures are designed to assure maximum colour preservation.

MAXIMUM FRESHNESS

VIRTUALLY

MOULD & DUST FREE

HIGHLY PALATABLE

Maximum freshness, extremely palatable and virtually mould and dust free are all related distinctions that pertain to BAD's unique processing procedure. Prompt dehydration assures freshness and restricts mould growth. Considerable drying retention time kills mould. Cubing eliminates dust. This combination of features creates a virtually mould and dust free, extremely fresh, and highly palatable product. The Equine Research Centre study (enclosed) states that Bio-Cube® products contain less than 4 % of the mould and dust particles that are present in good quality sun-cured hay.



INDIRECT HEAT

BAD1 uses low temperature indirect heating, stainless steel fluid bed driers. The heat medium for BAD1 is steam. The steam never gets in direct contact with the product. The striking advantage of indirect heat, over direct heat, is that direct flame can result in polluting the product. When combustible elements (such as coal and natural gas) are burnt, compounds such as sulphur are liberated along with the heat. Many European countries have prohibited direct flame dehydration of foods, for safety reasons. The safety concern is that the residues emitted from the combustible element will contaminate the food. BAD's indirect steam, besides being environmentally friendly, is never in direct contact with the product thereby eliminating any possibility for contamination.

MINIMUM HEAT DAMAGE

During dehydration, the important nutritional property which is known to be affected by air temperature is protein solubility. Results indicate that at 200°C the protein solubility was found to reduce considerably, when the leaf sample was exposed for more than 1.25 minutes. The driers used at BAD never reach that high of an air temperature. Furthermore, studies have shown that maximum bypass protein production occurs at around 150°C for 15 to 20 retention time. This closely matches our production conditions. The added value generated by our process can vary depending on the consumer's priorities. For anyone who seeks the best the added value could easily reach 60%, over sun-cured hay, and exceed 25% over direct heat, high temperature dehydrated hay. The table below reviews the benefits associated with BAD's indirect heat, low-temperature (IH-LT) dehydration process versus direct heat, high temperature (DH-HT) dehydration, showing the added value of each over sun-cured.

Benefits	Added Value Over Sun-Cured	
	DH-HT Dehydration	IH-LT Dehydration
Optimum Nutrient Retention	20-40%	20 - 40 %
Maximum Vitamin Preservation	6 - 8 %	6 - 8 %
Phytosanitation	1%	1 %
Utmost Feed Safety	N/A	5 - 10%
Maximum Colour	1%	2%
Maximum Freshness, Highly Palatable, and Virtually Mould & Dust Free	4%	6%
Free of Smoke Contamination	N/A	2-5%
Minimum Heat Damage & Optimum Bypass Protein Production	N/A	1%



As summarized above, compared to sun-curing the benefits of BAD's technology represents an increased value in quality averaging 52.5% depending on circumstances and customer priorities.

This added value is strictly the result of BAD's technological processing. It does not incorporate BAD's other quality convictions, such as our "Seed to Stable" quality assurance program. In contrast to conventional DH-HT dehydration, BAD's technology promotes an increased value in quality. Averaging a minimum of 16% and in most cases is much higher, depending on the affects of air temperature, vitamin preservation, deactivation of toxins (both plant and fungal), and antinutritional factors. BAD's processing procedures were conceived with nutritive quality as it's primary objective, and it remains our highest priority.

In conclusion, BAD is committed to promoting the well being of the horse by providing superior quality forage products. BAD's technology and perspectives are to insure maximum nutritive retention of forages, while maximizing inactivation of contaminants. This results in a product that is nutritionally and hygienically superior.



REFERENCES

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Comparison of Equine Forage Choices

Select Alfalfa Cubes

Conventional dehydrated alfalfa cubes

Sun cured alfalfa cubes

Alfalfa hay

BENEFITS	Select Alfalfa Cubes	Conventional dehydrated alfalfa cubes	Sun cured alfalfa cubes	Alfalfa hay
High Quality long stem fibre source	✓	✓	✓	✓
Virtually no mould or dust	✓	✓	✓	
Ease of handling	✓	✓	✓	
Less Wastage	✓	✓	✓	
Feed consistency	✓	✓	✓	
Most nutrient retention	✓			
Most vitamin preservation	✓			
Maximum preservation of colour	✓			
Maximum freshness	✓			
Minimum heat damage	✓			
Maximum palatability	✓			
Maximum bypass protein production	✓			
Maximum phytosanitation	✓			
Superior nutrient content	✓			