Research, Validation and Commercialization of Technologies

SGP+™/SGP+2.0™ Ration Part 1: Protein

Based on analysis and scientic study, SGP+™/SGP+2.0™ has been shown to contain more than adequate protein for dairy cow nutrition.

1. Repeated Forage Analysis shows that when 80% SGP+™ is mixed with 20% Cracked Corn, the Crude Protein as % of Dry Matter ranges from 6.0-7.0%.
   - 1.1. See attached Forage Analysis performed by Cumberland Valley Analytical Services on ration prepared at Deer Run Ranch in Jefferson, Texas.
   - 1.2. Nearly a half-dozen tests (Forage Analysis) have been performed all showing similar ranges (taking into account minor variations in ration mix).

2. Where does the remaining protein requirements come from?
   - 2.1. These CANNOT be shown by Forage Analysis.
   - 2.2. "Chemically pretreated (delignified) sugarcane bagasse…shown to contain 22.6% of crude protein."
     - 2.2.1. See (https://doi.org/10.1016/0921-3449(94)90007-8).
   - 2.3. IFUS pretreats bagasse with Nutri-Mastic™ and Carob.
     - 2.3.1. This pretreatment does NOT use harsh synthetic chemicals.
     - 2.3.2. Rather, SGP+™/SGP+2.0™ contains ALL-NATURAL ingredients that are either produced by nature or are found in nature.

3. Where is the evidence that supports the claim that 80% SGP+™/SGP+2.0™ mixed with 20% added ration per any given location contains adequate protein for bovine nutrition?
   - 3.1. Probiotic microbes that degrade lignin are scientifically proven to reside in sugarcane bagasse…both treated and untreated.
     - 3.1.1. These microbes have been scientifically shown to produce natural chemical substances that aid in the digestion of bovine ration, to include the secretion of the laccase enzyme lacked by bovines, yet necessary to digest lignin *in vivo*.
   - 3.2. Herds on SGP+™ show NO fly larvae in the manure pats and a lack of flies on the herd itself.
     - 3.2.1. Face Flies and Horn Flies lay their eggs in cow manure, and the larvae only develop in cow manure.
       - 3.2.1.1. The reason is that the larvae require nutrition derived by microbial breakdown of undigested lignin.
       - 3.2.1.2. Hence, no lignin = no microbial breakdown = no larvae nutrition = no larvae = reduced or eliminated fly population.

3.2.1.3. Lastly, herd performance indicates that, while it cannot be completely explained at the moment, the degraded and depolymerized lignin is providing to the cow "…the Holy Grail of energy and nutrition…" (as stated by Dr. Pat Bagley on the nature of lignin).

3.2.1.3.1. The only plausible explanation is that the nutrition and energy are coming from degraded and/or depolymerized lignin.

3.2.2. Furthermore, ranchers are reporting the lack of Dung beetles on the manure.

3.2.2.1. https://blogs.cornell.edu/beefcattle/2020/05/21/new-publication-on-dung-beetles/

3.2.2.2. "The beetles are attracted by the smell, and can find a new cowpat within seconds."

3.2.2.3. Ranchers and dairymen are reporting decreased or complete elimination of manure smells and odor, further supporting the claim of lignin degradation and depolymerization into TDN and CP.

3.2.2.4. Lignin Digested in Upper GI of Cow = No furfurals produced in lower GI = No furfurals produced = No smell = No Dung Beetles in and on manure.

3.3. Ration Mix containing 80% SGP™/SGP+2.0™ is consistently shown to produce a Manure Score of 3 in both beef and dairy cows.

3.3.1. Dr. Robert Wells, formerly of the Nobel Research Institute and now Professor of the Practice and Paul C. Genho Endowed Chair in Ranch Management, King Ranch Institute (https://krirm.tamuk.edu/robert-wells-ph-d-pas/) has developed a system by which "Manure scoring determines supplementation needs" (https://www.noble.org/regenerative-agriculture/livestock/manure-scoring-determines-supplementation-needs/).

3.3.1.1. In this system, a Score 3 Manure Pat has been shown to contain: "12-15% CP; 62-70% TDN of diet."

3.3.1.2. "Manure score 3 is ideal and will typically start to take on a normal pat form. The consistency will be similar to thick pancake batter. It will exhibit a slight divot in the middle. The pat will be deeper than a score 2 pat, but will not stack. This diet is not lacking nutritionally, yet is not in excess for the cow and her physiological stage."

3.3.1.3. "Score 4 manure is thick and starting to become somewhat deeper, yet is not stacking. The consistency of the manure will be equivalent to peanut butter. This manure indicates a lack of degradable rumen protein, excess low quality fiber or not enough carbohydrates in the diet. Supplementation of additional protein with high rumen-degradable protein can increase total diet digestibility. Cottonseed meal and soybean meal are excellent sources of this type of protein."

3.3.1.4. Dr. Wells provides guidance on nutritional adjustments that can be made in bovine ration to move the herd from under-performing nutritional mixes to optimized ration mixes.

3.3.1.5. Ranchers and dairymen following Dr. Wells ration management guidance when utilizing SGP+™ have consistently reported a rapid transformation to Score 3 Manure Pats followed by a list of herd performance improvements.

3.3.1.6. The health, costs, and herd performance implications of healthy ration as indicated by Manure Scoring are candidly staggering.

3.3.2. Lastly, Herd Performance and other observations as reported by ranchers and dairymen as well as Animal Scientists, DVM's, and visitors tell a story of:

3.3.2.1. Reduced Ration Consumption Supporting Improved Satiation

3.3.2.2. No Pasture Odors with Reduced Flatulence and Mouth Discharge with reduced Greenhouse Gases/Carbon Footprint.

3.3.2.3. Higher Quality/Quantity Meat, Milk, and Colostrum.

3.3.2.4. Reduced Infant Mortality/Miscarriages with Higher Quality Calves.

3.3.2.5. Reduced Antibiotic Application/Improved Herd Health.

3.3.2.6. Reduced Costs, Higher Revenues, and Higher Profits.

3.3.2.7. Reduced Fly/Insect Infestations.

3.3.2.8. Improved Manure Quality and Degradation for Natural Replenishment of Top Soil.

3.3.2.9. Lower Hydration Requirements and Improved heat Tolerance.

3.4. Ration Management at 80%SGP+™/SGP+2.0™ to 20% Other Ration Reconciled to Herd Performance Clearly Demonstrating adequate CP:

3.4.1. Deer Run Ranch (Nearly 12 years of successful application and nearly 1000 head of cattle)

3.4.1.1. IFUS' 1st Customer.

3.4.1.2. Now feeding 80%SGP+™ / 20% Cracked Corn.

3.4.1.3. Buys Score 1 of 5 Cattle and transforms to Score 3 of 5.

3.4.1.4. Report record Herd Performance, Decreased Costs, Increased Revenues, and Increased Profits.

3.4.1.5. Superior Meat Quality noted by Butchers.

3.4.1.6. Results substantiated by Animal Scientists, DVM's, and other ranchers/dairymen.

3.4.1.7. Based on success of Joe Wilcox, moving to reduce or eliminate cracked corn by replacing with Distillers Grain (DG) at 92% SGP™/4% Cracked Corn/ 4% DG.

3.4.2. Joe Wilcox (Now in 3rd Year of successful application)

3.4.2.1. Now moving to 92% SGP+™ to 8% Distillers Grain (DG) with outstanding Herd Performance as indicated above.

3.4.2.1.1. Joe's success is now in a 3rd Phase Blind Trial at the Oklahoma/Kansas Border.

3.4.2.1.1.1. Initial data has proven this to be HIHGLY successful.

3.4.2.1.1.2. Jow now planning an expanded trial on an expanded 200 head.

3.4.2.1.2. Forage there is poor at best

3.4.2.1.3. Joe has eliminated corn from his ration mix

3.4.2.1.4. Furthermore, Joe's Herd Performance is such that he now free ranges with 92%SGP+™/8%DG and sells directly to market without the need for finishing at a feedlot.

3.4.2.1.4.1. The economic, environmental, and overall health/safety implications of this success are significant at the least.

3.4.2.2. The science supporting Joe's recent efforts includes:

3.4.2.2.1. "Data were therefore collated to provide a comprehensive overview of these natural products. DGs are rich in phenols, phytosterols, and fatty acids, in addition to general lipid and protein constituents. These compounds and their related extracts possess diverse biological activities, including antioxidant, anti-inflammatory, and anti-hyperglycaemic effects." Recent Progress in Distiller's Grains: Chemical Compositions and Biological Activities

3.4.2.2.1.1. Ran He, Yubo Yang, Yongsu Li, Minghua Yang, Lingyi Kong, Fan Yang, Molecules. 2023 Nov 9;28(22):7492. doi: 10.3390/molecules28227492

3.4.2.2.2. "Maize-based distillers grains from the ethanol industry are commonly sold as a high protein livestock feed that increases efficiency and lowers the risk of subacute acidosis in beef cattle.[2]" "Fact Sheets for Feeding Distillers Grains" (PDF). Archived from the original (PDF) on 2011-11-12.

3.4.2.2.3. Also, distillers grains are said to convert starch into glucose.

3.4.2.2.4. In mammalian physiology Sugarcane Sugar (sucrose) is considered significantly healthier than HFSC (High-Fructose Corn Sweeteners). The reason is that Glycolysis requires one glucose to one fructose.

3.4.2.2.4.1. Sucrose contains one glucose and one sucrose.

3.4.2.2.4.2. Corn contains primarily fructose.

3.4.2.2.4.3. Excess fructose in mammals is converted into phenylalanine. In excess, phenylalanine is toxic as it causes PKU (Phenylketonuria). One of the effects of PKU is mental retardation (amongst other not so good things).

3.4.2.2.5. Joe's success is now moving into a 4th and expand Blind Trial at the Oklahoma/Kansas Border

3.4.2.2.5.1. Forage there is poor at best

3.4.3. India / SUMUL Dairy (Successful 1st Round Trial now transitioning into 2nd Round Expanded Trial)

3.4.3.1. Intention of trial was to determine herd acceptance.

3.4.3.2. IFUS expects that when Sugarcane bagasse from India is formulated with Nutri-Mastic™, Carob, and Silage from Sugarcane tops, SGP+2.0™ will prove to be a superior product to SGP+™ made from bagasse in the U.S.

3.4.3.2.1.1. This is supported by the 15-day trial on 2 Non-lactating Holstein-Friesian (HF) Crossbred Heifers (ages 4 and 3.5 years) at 940lbs and 748 lbs, respectively.

3.4.3.2.1.2. Results Exceeded Expectations as Improvements Clearly support lignin degradation and depolymerization with more than adequate CP.

3.4.3.2.1.2.1. Manure score improved after 2 weeks

3.4.3.2.1.2.2. Where Milk fat percentage were the same, SNF (Solid-non-fat) percent increased by 0.6-0.8%.

3.4.3.2.1.2.2.1. SNF typically ranges around 8%. A 0.6-0.8% increase = 7.5 – 10.0% increase in SNF.

3.4.3.2.1.2.2.1.1. Lysine-effect (See Section 4.3.1 for production of lysine and other essential amino-acids from degraded/depolymerized lignin)

3.4.3.2.1.2.2.2. SNF = The substances in milk other than water and butterfat left after the complete evaporation of water from milk.

3.4.3.2.1.2.2.3. SNF in milk includes lactose, vitamins, calcium, minerals, fat, protein, and other nutrients. These contribute significantly to the nutritive value of milk.

3.4.3.2.1.2.3. Hide shine improved after 10 days.

3.4.3.2.1.3. The surprising and encouraging results occurred with only a fraction of SGP+2.0™ being fed for only 15 days.

3.4.3.2.2. Hence, a significantly expanded trial is now being designed at SUMUL.

4. Here are samples of additional science that supports the above stated claims of Crude Protein (CP):

4.1.1. "Intracellular pathways for lignin catabolism in white-rot fungi", Carlos del Cerro, Erika Erickson, Tao Dong, and Davinia Salvachúa, February 23, 2021, 118 (9) e2017381118, https://doi.org/10.1073/pnas.2017381118.

4.1.1.1. This is one of hundreds of scientific studies that provide a plausible explanation for record weight gain in shorten time periods on beef cattle fed

a ration mix containing SGP+™. Within this study, Figure 2 shows but one of many such metabolic cycles whereby critical amino acids (proteinogenic) required for bovine herd performance are actually generated in the degradation and depolymerization of lignin by White Rot Fungi and other beneficial microbes. These microbes are found in sugarcane bagasse and physical observation of SGP+™ coupled with Manure Scoring and other herd performance measurements performed by ranchers clearly establish a pattern of improved herd performance, reduction in costs coupled with improved profits, and positive environmental impacts. Dairy cows are expected to perform equally as well, if not better on SGP+2.0™.

4.1.1.1.1. Forage analysis cannot show this.

4.1.2. "White-rot Fungi Eat All the Components of the Wood They Decompose," Davinia Salvachúa Rodríguez, Environmental Molecular Sciences Laboratory, March 8, 2021." National Renewable Energy Laboratory, Golden, Colorado

4.1.2.1. Lignin accounts for 30 percent of the organic carbon on Earth. Therefore, white-rot fungi—the most efficient lignin-degrading organisms—play a critical role in global carbon cycling. A longstanding belief was that white-rot fungi convert lignin to CO_2 and H_2O outside their cells to simply gain access to the plant cell wall sugars that compose cellulose. The current study overturns this decades-old dogma by demonstrating that white-rot fungi also incorporate carbon from lignin-derived compounds. Furthermore, this study establishes a foundation for employing white-rot fungi in biotechnological applications, such as lignin bioconversion into value-added products, which is a key step toward enabling a sustainable plant-based bioeconomy.

4.1.2.2. The team used these 13C-labeled chemicals as the carbon source in fungal cultures to track their utilization through the central metabolism of fungal cells. The team selected two species of white-rot fungi that use different mechanisms to degrade lignin and cellulose. Using this system, they discovered that the fungi converted the 13C-labeled aromatic compounds into amino acids, which are the main components of proteins.

4.1.2.2.1. Again, forage analysis cannot show this.

4.1.3. However, in a forage analysis (attached) and performed on a ration mix of 80% SGP+™ and 20% Cracked Corn, Cumberland Valley Analytical Laboratories determined the Crude Protein to be 6.5% of Dry Matter.

4.1.3.1. Where most nutritionist would indicate this level of Crude Protein to be insufficient for all categories of heifers in their stages of development and gestational cycles, what Forage Analysis cannot determine is the degradation and depolymerization of lignin *in vivo* from the laccase enzyme produce by the White Rot Fungi as well as other digestive enzymes produced by other beneficial microbes established to be present in sugarcane bagasse.

4.1.3.1.1. "The fungus Pleurotus ostreatus NRRL-2366 degraded 56.7% and 45.9% of untreated and chemically pretreated (delignified) sugarcane bagasse, respectively, during 14-day incubation in a submerged fermentation process. The biodegradation percentages of cellulose, hemicellulose and lignin were 33.0%, 72.5% and 14.5%, respectively. An increment of **22.6% of crude protein** content in the residual fermented material was observed. Chemical composition of the end-product and its amino acids profile were reported." "Bioconversion of sugarcane bagasse into a protein-rich product by white rot fungus", Samir A. El-Sayed, Mohamed T. Zaki, and Amal W. Abou El-Khair, Resources, Conservation and Recycling, Volume 12, Issues 3–4, November 1994, Pages 195-200 (https://doi.org/10.1016/0921-3449(94)90007-8)

4.1.3.2. Furthermore, the Forage Report shows a decrease in lignin from an average of 28% in unformulated sugarcane bagasse to 19.9% NDF and 9% of dry matter. This is indicative of the effect of White Rot Fungi and other beneficial microbes degrading and depolymerizing the lignin within the SGP+™ formulation.

4.1.3.2.1.1. However, this measure is again limited to *in vitro* and not *in vivo/in situ* digestion.

4.1.3.2.1.2. (Again, See Forage Report on "Sugarcane Waste, Deer Run Ranch, LAB ID: 34710 041, Cumberland Valley Analytical Services 11/30/2023)

4.1.3.3. SGP+2.0™ will use silage from sugarcane tops. Current thinking is that once formulated and accepted by the herds, protein concentrate, added grains, or even hay will be significantly reduced and possibly even eliminated.

4.1.3.3.1. Present thermodynamic modeling on SGP+™ along with theoretical thermodynamic modeling on SGP+2.0™ being developed is suggesting this to be true.

4.1.3.3.2. Additionally, Energy/Mass balancing used in paper mills in the form of an Input/Output model applying Forage Analysis, Manure Analysis, and Herd Performance is presently under development.

4.1.3.3.2.1. Early results are encouraging.

4.1.4. It is well-established that prior to the application of chemical fertilizers, insecticides, and herbicides, bovines received the vast majority of their required protein from beneficial fungi and bacteria on the forage. Once these microbes secreted digestive enzymes and other critical digestive chemicals, the HCl of the gastric system digested the protein content of the microbe itself. Hence, more than enough protein was made available to the cow.

4.1.4.1. "How Does a 1,200 Pound Cow Get Enough Protein?", Sam Westreich, PhD, Sharing Science, Aug 27, 2018

4.1.4.2. SGP+™ is believed to restore this natural balance

4.2. Lack of Fly Larvae in Manure Pats = No or Significantly Reduced Lignin in the Manure Pats.

4.2.1. "Flies are attracted to manure, animal feed and secretions around the animals' eyes and nose," said Swiger. "That's where we run into issues with flies going to manure, then back to secretions and possibly transmitting disease. One of the main ways to reduce flies is to reduce access to their preferred food source, which reduces the ability to produce eggs."

4.2.1.1. https://countryfolks.com/manure-flies-early-season-grazing/

4.2.1.1.1. These flies require nutrients in the manure to include undigested lignin.

4.2.1.1.2. The undigested lignin is digested by microbes in the manure, that then provide nutrition for the larvae.

4.2.1.1.3. Hence, no lignin, no nutrition, and no larvae.

4.2.1.2. Where did the lignin go?

4.2.1.2.1. Common Sense Answer: In the SGP+™ formulation mixed with ration at 80/20, the lignin is degraded and depolymerized by beneficial microbes into nutrition and energy required by the cow.

4.2.1.2.1.1. Why is this true?

4.2.1.2.1.1.1. In multiple trials, when the herd is removed from SGP+™, within days the flies return and larvae can once again be found in the manure pats.

4.3. Amino Acid Production from degraded and depolymerized lignin in Sugarcane Bagasse

4.3.1. Lysine is required for Milk Production to include Milk Fat.

4.3.1.1. "Lysine is one of the first two limiting amino acids in a lactating cow's diet. When cows have adequate lysine in the diet, milk production, components and cow health are more fully supported."

4.3.1.1.1. "However, lysine is lacking in almost all forage-based rations. Supplemental lysine supports cows to meet their potential. And certain lysine sources can do so in an efficient, cost-effective way."

4.3.1.1.1.1. https://www.purinamills.com/dairy-feed/education/detail/using-lysine-in-cattle-feed

4.3.1.2. However, based on colostrum and milk production reported by ranchers applying SGP+™ to their herds, IFUS has documented evidence in pictures and videos as to the effectiveness of SGP+™ in colostrum and milk production.

4.3.1.2.1. This has been substantiated by both Animal Scientists and DVM's at both Deer Run Ranch as well as blind trials being conducted on herds at the Oklahoma-Kansas border in the U.S.

4.3.1.3. Furthermore, several articles substantiate that Lysine is in fact produced in fermentation of residual sugars found in sugarcane bagasse and molasses.

4.3.1.3.1. "Comprehensive assessment of the L-lysine production process from fermentation of sugarcane molasses," Omar Anaya-Reza, Teresa Lopez-Arenas, Bioprocess Biosyst Eng. 2017 Jul;40(7):1033-1048. doi: 10.1007/s00449-017-1766-2. Epub 2017 Apr 13. (PMID: 28409400 DOI: 10.1007/s00449-017-1766-2)

4.3.1.4. Other studies show that Lysine and other critical amino acids are produced when lignin is degraded and depolymerized.

4.3.1.4.1. "Intracellular pathways for lignin catabolism in white-rot fungi," Carlos del Cerro, Erika Erickson, Tao Dong, and Davinia Salvachúa, February 23, 2021, 118 (9) e2017381118, https://doi.org/10.1073/pnas.2017381118., Edited by Caroline S. Harwood, University of Washington, Seattle, WA, and approved January 20,

4.3.1.4.1.1. "Then, we determined the level of 13C labeling in intracellular proteinogenic amino acids, which are metabolites derived from central carbon metabolism (Fig. 2A)."

5. Forage Analysis

5.1. Where forage analysis is a wonderful methodology to compare grass to grass quality, it is not designed (hence not capable) at this time of demonstrating the efficacy of a complete ration mix where SGP+™/SGP+2.0™ as the base of the formulation.

5.1.1. Where SGP+™/SGP+2.0™ is being said to be a potential "hay replacement," in reality, SGP+™/SGP+2.0™ is designed to increase the efficacy of ration management while reducing highest-priced components of any ration mix, and enhancing herd performance.

5.1.1.1. This is supported by Manure Scoring of herds being fed an 80%/20% SGP+™ ration.

5.1.2. "Forage analysis – Understanding our limits," Kyle Taysom, "Progressive Forage", November 15, 2011.

5.1.2.1. "However, one of the things RFV does not account for very well is the digestibility of fiber. This can become a problem when comparing hays with varying amounts of grass, as grass tends to have higher fiber digestibility than legumes."

5.1.2.2. “However, as the science of ruminant nutrition has evolved, so have the calculations for Nel, Neg and Nem.”

5.1.2.2.1. “Early equations were calculated solely from the ADF content of a feedstuff, then summative equations were created that included protein, fat, fiber, carbohydrates and ash.”

5.1.2.2.2. “Now some calculations for energy even include an adjustment for NDF digestibility and kernel processing.”

5.1.2.2.3. “Users should be cautious when comparing these calculations, as the choice of which calculation to use will largely determine the number produced.”

5.1.2.2.4. “For example, the Nel calculation for a hay sample may be 0.54 megacalories (Mcal) per pound for the OARDC summative equation, but 0.64 Mcal per pound for a calculation based only on ADF.”

5.1.2.3. “Perhaps the most common calculation, RFV is a calculation based on the amount of fiber in a forage sample.”

5.1.2.3.1. “In recognition of the importance of fiber digestibility, RFQ was created. This index is on the same scale as RFV with an adjustment for fiber digestibility (NDFD), and is an excellent tool for comparing hays with varying amounts of grass and legume contents.”

5.1.2.3.2. “Unfortunately, the analytical procedure for NDFD requires live animals and is largely dependent on the diets which these animals are fed, so standardizing NDFD across labs is nearly impossible.”

5.1.2.3.3. “This means NDFD cannot be compared directly across labs and comparison of RFQ across labs is murky at best.”

5.1.3. Dr. Joanne Sililiano-Jones of the F.A.R.M.E. Institute, Inc. (Courtesy of All-tech Inc.) also questions the limitations of Forage Analysis.

5.1.3.1. “Strategies for coping with poor forage digestibility in dairy rations: response to enzyme supplements”, Published on: 02/08/2007.

5.1.4. Many nutritionists caution that because of the correlation between ADF and feed energy, the detergent fibers are widely used to estimate the energy content of feeds. Based on practical experience, many of these nutritionists have reservations about this practice.

5.1.4.1. One of the developers of the detergent fiber system even warns against using it this way: “The use of either NDF or ADF to predict value of forages are mis-uses, because of the failure to consider rational models of the availability of forage fractions…” –P.J. Van Soest (1993).

5.1.4.2. The failure of detergent fibers to predict energy content can be traced to the mechanisms that control cell wall digestibility. These include lignin encrustation of the plant cell wall (physical effect), how tightly cellulose

strands are woven together, and the amount of open space within the plant cell wall that is accessible to fibrolytic bacteria and/or enzymes."

5.1.4.3. Unpredictable (generally lower than expected) digestibility of forage fiber is a major problem in balancing dairy rations that perform as expected.

5.1.5. If Forage Analysis is to remain an adequate measure by which a baseline of CP and TDN are to be determined in bovine ration management, then it must evolve to accommodate new ration ingredients, which then serve as the base ingredient of said ration.

5.1.5.1. SGP+™ is just such an ingredient and technology. This claim is supported by reports from ranchers and dairymen on improved herd performance, improved profits resulting from decreased costs and increased revenues, and improved environmental impacts.

5.1.5.2. The same can be said for SGP+2.0™ as it evolves into a superior ration management protocol.

5.1.6. Hence, IFUS is in the process of developing ration management modeling to accommodate for these changes in ration formulation.

6. SGP+™ vs. SGP+2.0™

6.1. Considering the lignin content of Sugarcane varieties planted in the U.S. (specifically Louisiana) as compared to Sugarcane varieties planted in India, it is widely accepted that the lignin content found in Louisiana averages around 28%, while in India the number is significantly lower as it averages about 19%.

6.1.1. Furthermore, there is discussions regarding S- and H- lignin's, which is differentiated by any number of factors, one of most significance being cross-linking of the polymer chain.

6.1.2. In a video on U-Tube titled Lignin Structure Building Demonstration (https://youtu.be/Y6DqY7BlXuw?si=0cniSUpSy3kdn2Fp), one can visually see a form of lignin containing the S- and H- regions (clustered molecules vs tails/limbs away from the main cluster). "Softwood lignin is composed of mainly G-units with a small amount of H-unit lignin, while hardwood lignin consists of both G- and S-units. Herbaceous plant lignin contains all three monolignol units of G, S, and H units, and p-coumarate and ferulate, which are incorporated with normal G- and S-units."

6.1.2.1. It is suggested that the lignin found in India's Sugarcane, has a lower percentage of cross-links.

6.1.2.2. This exposes more surface area for natural microbial degradation and depolymerization of lignin in a shorter time span.

6.1.2.3. Subsequently, one would expect greater ease of digested nutrients in both CP and TDN of SGP+2.0™ as compared to SGP+™.

6.1.2.4. However, where some of this would be present pre-digestion in the cow, much of it would occur *in vivo/in situ.*

6.1.2.5. Creating a proper ration mix will thus be of vital importance so as to maximize the efficacy of SGP+2.0™. This may well result in SGP+2.0™ becoming a superior product to SGP+™ with a need to add little or no other ingredients to achieve desired Herd Performance.

6.1.3. Lastly, as an interesting aside, any number of studies report of synergistic biochemical pathways of Mastic, Carob, and Lignin in antioxidant and antimicrobial activity.

6.1.3.1. "The chemical structure of lignin, that is, the monolignols and their linkages, is dependent on the biomass type and the procedure used for lignin isolation. The resulting structural differences also influence the lignin's properties such as antioxidant and antimicrobial activity, which are here presented and discussed including most recently reported data. There is a high potential in the usage of multivariate data processing (e.g., nuclear magnetic resonance (NMR) and Fourier-transform infrared (FTIR) spectra) in current lignin structure analysis and quality control. Current studies in lignin valorization focus applications in biomedicine such as lignin-based drug release and scaffolds for stem cell–based tissue engineering, both will briefly be presented."

6.1.3.1.1. Chapter 4 - Types of lignin, properties, and structural characterization techniques, Jessica Rumpf. Xuan Tung Do, Rene Burger, Yulia Monakhova, Margit Schulze, Lignin-Based Materials for Biomedical Applications: Preparation, Characterization, and Implementation, 2021, Pages 105-158