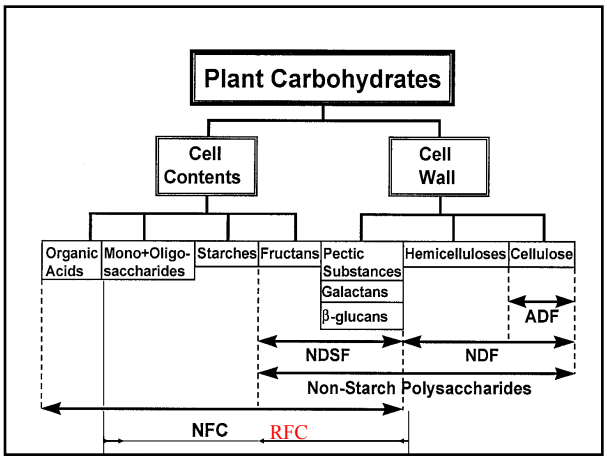
Impact of Post Harvest Forage on the Rumen Function

Gbenga Ayangbile, Ph.D.

Established Facts

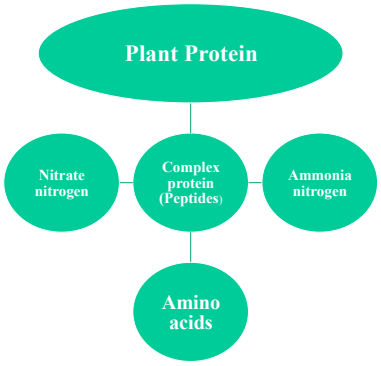
- Most nutrients in fresh forages before harvesting are more available and efficiently utilized for productive purposes in livestock production.
- However post harvesting with or without a form of preservation is known to reduce the availability and quality of these nutrients.



Known Facts

- Forage Cell Contents with their natural organic acids, mono and oligosaccharides, starches, fructans usually do not improve in nutrient qualities after harvesting.
- However, post harvesting of the forage followed by some forms of conservation methods; are known to improve the nutrient qualities of the Cell Wall contents such as NDF pectic substances e.g galactans,beta-glucans, hemicellulose and ADF celluloses.

Protein qualities in Pre-harvest forages



Known Facts

- Proteins in pre-harvest forages are of greater qualities; and are sensitive to various forms of degradation or biochemical transformation after harvesting.
- Depending on methods of conservation at harvest, most of the non-protein nitrogen may be converted to utilizable proteins for the Rumen Function.

Benefits from Pre Harvest Forages

- Ensuring availability of forage to the animals post forage growing season.
- Improved palatability to the animals.
- Improved digestibility and nutrient qualities of cell wall carbohydrates and non-protein nitrogen through effective post harvest conservation methods.

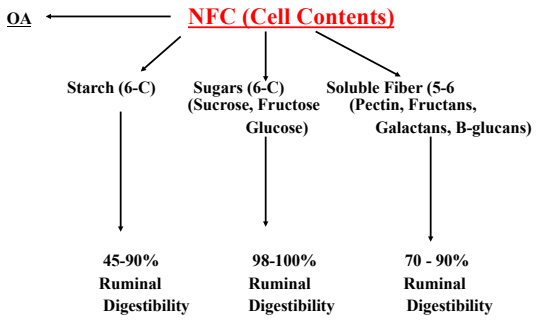
Comparing the Benefits from the Pre and Post Harvested Forages

CELL CONTENTS

VS

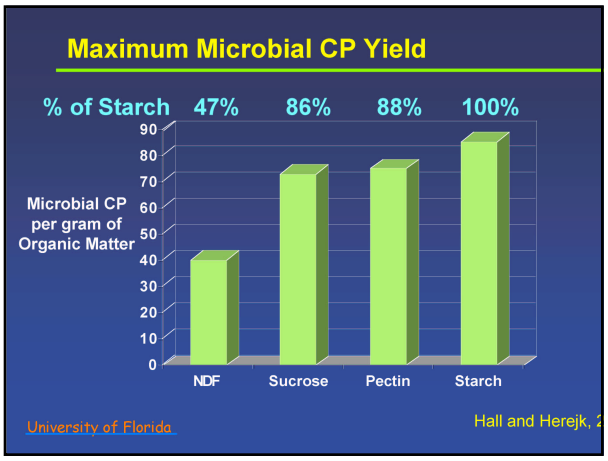
CELL WALLS

Constituents of forage carbohydrates



Percent DM of Sugars in fresh Pastures and other harvested forages (averages < 500 samples)

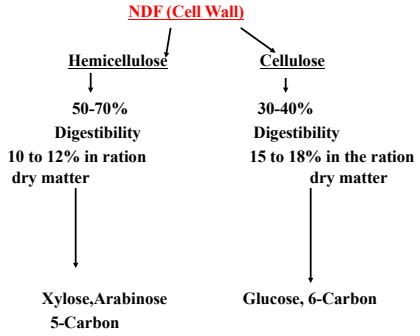
Items	Arabinose	Fructose	Glucose	Sucrose	Xylose	NFC	Starch
Pasture	2.56	4.37	2.74	1.23	7.75		0
Hay	1.4	2.77	1.45	0.76	8.8	26.15	0
Balage	1.43	5.05	1.98	0.959	5.95	29.1	0
Haylage	1.3	2.59	1.14	1.26	5.7	29.06	0
Grass silage	1.37	1.93	0.49	0.67	10.17	20.28	0
CS	0	0.233	0.248	0.71	12.6	43.84	31.93



Chemical changes in Forages Post Harvest

- Most post harvested forages are matured and high in fiber contents as Sugar level decreases.
- As plant matures, 5 carbon sugars such as arabinose are converted to Hemicelluloses.
- And 6 carbon sugars such as glucose are converted to starch and cellulose.
- In corn forage and others, glucose is converted to starch.
- With maturity, LIGNIN strongly binds the hemicelluloses and cellulose, thus reduce animal digestibility.

Constituents of forage cell wall carbohydrates



Percent DMD and Cell wall contents in fresh Pastures and harvested forages (averages < 500 samples)

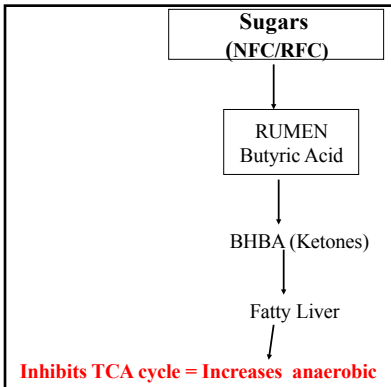
Items	IVDMD	CWD	NDF	ADF	HEM	CP	SP
Pasture	82.26	79.54	41.62	22.26	19.37	24.5	40.2
Balage	73.78	56.99	42.64	28.85	13.79	19.71	51.43
Haylage	75.02	60.38	40.03	28.35	11.68	21.92	58.97
Grass silage	66.49	53.47	58.04	35.54	22.5	13.08	60.13
Hay	67.14	57.29	50.39	33.02	17.37	17.64	33.17
CS	73.25	51.91	42.23	24.83	17.4	7.93	57.36

Cell contents vs Cell walls sugars in the Rumen

The profile and ratio of energy metabolites produced in the rumen when Cell Contents and Cell walls fractions are fed to the animals may help diet formulators on how to formulate more efficiently.

In Vitro Rumen Microbial VFA Production from the Sugars in Pre and Post harvest Forages

Sugars	Types of chain	% Acetate	% Propionic	% Butyric	Total VFA, um/ml	Acetate+Butyric/Propionate ratio
Starch	6	56.23	16.93	26.61	25.27	4.89
Galactose	6	47.18	10.46	40.71	22.14	8.40
Fructose	6	52.49	7.54	39.54	20.51	12.21
Glucose	6	51.06	10.45	38.08	24.67	8.53
Pectin	5	86.03	6.12	7.86	25.98	15.34
Xylose	5	71.69	13.66	14.65	24.12	6.32
Arabinose	5	71.87	13.39	14.69	27.93	6.46



Inhibits TCA cycle = Increases anaerobic glycolysis, blood glucose and blood lactate. Reduction in Propionate conversion to Glucose

Since the season of harvest affect the nutrients profile, how much impact does the nutrient change played on the Rumen function?

Distribution of sugars (%) in Grasses

Item	Sucrose (6 C)	Fructose (6 C)	Glucose (6 C)	Ribose (5 C)	Xylose (5 C)
BTR9 1st	0.774	3.70	3.67	16.23	52.19
BTR9 2nd	0.284	3.23	2.83	11.03	49.35
BTR9 3rd	0.538	7.15	5.90	10.27	43.16

Comparison of %sugars to NDF, NFC and CWD in Grasses

Item	5 Carbon Sugars	NDF	Sol. 5 and 6 Carbon Sugars	NFC	CWD
BTR9 1st Cut	60.53	53.38	16.03	18.04	56.84
BTR9 2nd Cut	53.72	55.26	13.01	18.04	54.81
BTR9 3rd Cut	46.48	46.11	20.54	27.62	51.54

Distribution of sugars (%) in Grasses

Item	Sucrose (6 C)	Fructose (6 C)	Glucose (6 C)	Ribose (5 C)	Xylose (5 C)
Barfest 1st Cut	0.936	5.52	5.27	12.15	31.57
Barfest 2nd Cut	0.476	1.46	2.35	15.28	49.67
Barfest 3rd Cut	0.371	8.50	7.02	11.31	33.8

Comparison of sugars to NDF, NFC and CWD in Grasses

Item	5 Carbon Sugars	NDF	Sol. 5 and 6 Carbon Sugars	NFC	CWD
Barfest 1st Cut	35.44	44.78	20.02	21.55	67.9
Barfest 2nd Cut	57.94	58.76	11.29	16.32	58.62
Barfest 3rd Cut	38.17	40.52	22.83	32.78	57.38

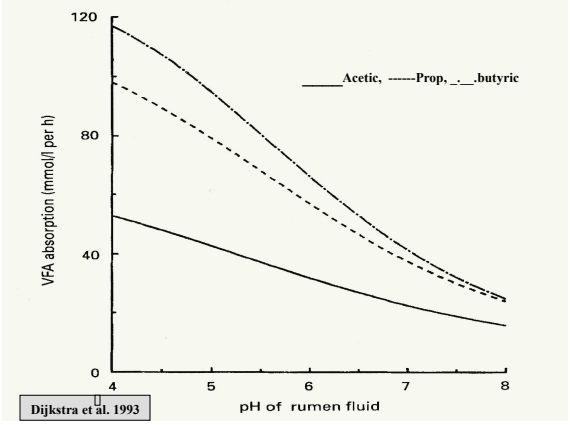
VFA Profile of Grasses as affected by Sugars Composition

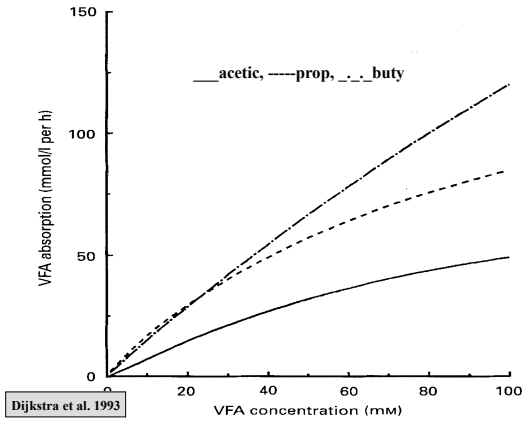
Item	% Acetate	% Propionic	% Butyric
Barfest 1st Cut	63.7	14.1	15.9
Barfest 2nd Cut	69.7	15.2	12.7
Barfest 3rd Cut	57.6	17.5	21.4

Effect of Types of sugars in feedstuffs on the Production of Energy for Cows

Sugar Type	Type of ingredient	Acetic%	Prop. %	Buty. %	Total VFA, um/ml
Starch	CS, Corn	56.23	16.93	26.61	25.27
Fructose	Hay	52.49	7.54	39.54	20.51
Glucose	Hay	51.06	10.45	38.08	24.67
Arabinose	Pastures	71.87	13.39	14.69	27.93
Pectin	Alf., Soy hull	86.03	6.12	7.86	25.98
Xylose	Hay, Hlg	71.69	13.66	14.65	24.12

When there is excessive concentration of **BUTYRIC** acid in the RUMEN as a result of overproduction, this excess may cause low performance and initiation of metabolic problems especially in pre and post fresh cows.





The Graphs show:

a) absorption of VFA when rumen pH is <6.3 is in the order of Butyrate>Propionate>Acetate

b) absorption of VFA into the blood decreased as rumen pH increased

c) as the total VFA concentration in the rumen increased, absorption of acetate and propionate decreased but butyrate is not affected

Protein qualities in Post-harvest forages

- Depending on methods of conservation at Post harvest, most of the non-proteinous nitrogen may be converted to efficient utilizable proteins for the Rumen Function.
- While others are transformed from quality complex proteins to soluble proteins.
- Excess Soluble Proteins in an unbalanced rations may be toxic to cows.

Impact of Post-Harvest on Transformation of Nitrogen in Fresh Alfalfa.

Items	% CP	%SP	Ammonia, ppm
Fresh chopped Alfalfa	25.12	32.7	133.83
Alfalfa Balage @ 60 d	25.3	67.9	2494

Fate of Ammonia ingested in Post Harvested forages

- Approximately 1/3rd of Rumen Bacteria required ammonia with other cofactors to synthesize microbial protein (70% bypass).
- Excess dietary ammonia is toxic if the animal's liver is limited in detoxify it.

Fate of Ammonia ingested in Post Harvested forages

- MUN is a great indicator of how much dietary ammonia is produced and detoxified.
- Accumulated ammonia changes the acid-base balance of the cells (metabolic problems especially post calving).

Soluble protein

↓

Elevated Rumen Ammonia

↓

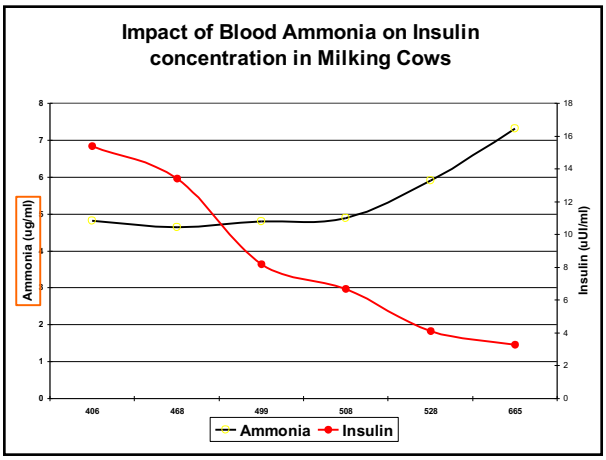
Blood ammonia toxicity

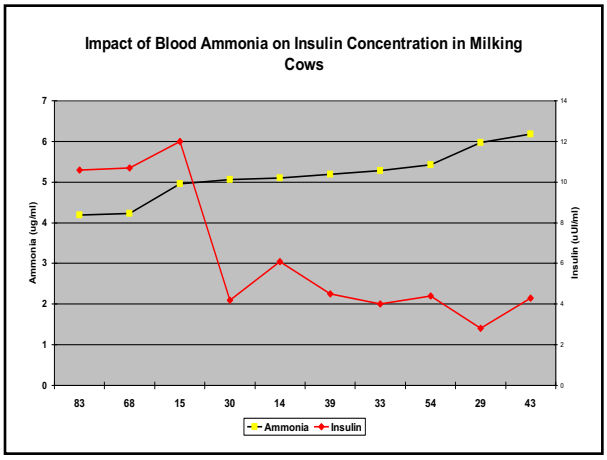
↓

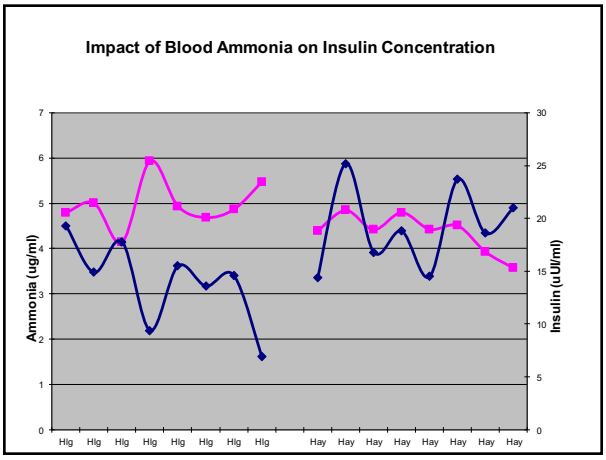
Over worked Liver

↓

Inhibits TCA cycle = Increases anaerobic glycolysis, blood glucose and blood lactate. Reduction in Propionate conversion to Glucose







Conclusion

Nutrients in forages pre harvest are naturally of greater quality for animal production.

Post harvesting of forages is necessary to meet the feed demands and quality needed for animal production.

Many studies showed that a form of preservation is needed during harvesting to control spoilage, improve palatability and digestibility to the animals.

Conclusion

The sugar types in the cell contents and cell wall varied according to the season, maturity and preservation methods.

It would be a great benefit to formulate rations according to the ways the Rumen Bacteria see these sugars.

Understanding how to combine these sugars in the diet with variable forms of forage proteins will help maximize Rumen microbial functions.

Thank You