Effect of oat type (feed-type vs. milling type) and processing method on true nutrient supply to dairy cattle

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INTRODUCTION

- ✓ Study 1:
  - ✓ Why do use oat as animal feed?
  - ✓ Effect of oat type

- ✓ Study 2:
  - ✓ What do expect from processing method?
  - ✓ Effect of processing method

Why do use oats as animal feed?

- Oat (*Avena sativa* L.):
  - Used as human food:
    - Positive health benefits;
  - Introduced as animal feed:
    - Its relative **low price** and improved nutritional value of new varieties:
      - Development of new oat varieties:
        - **CDC Nasser**: lower content of lignin in the hulls, higher fat content.
        - **CDC Seabiscuit**: higher yield and lower fat content

What does expect from processing method?

- Heat processing:
  - May show controversial results, because heat procedures are not often optimal;
- Dry heating:
  - The most common heating process;
  - Can overheat the surface of the grain and undercook the inner layer.
- Alternative heat processing:

heating

Microwave irradiation

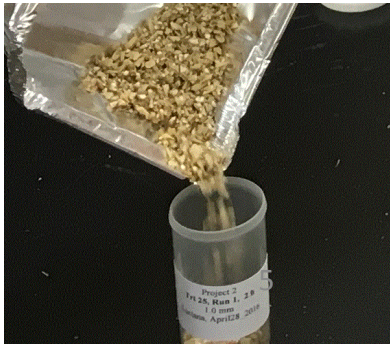
- *Study 1:*
  - To evaluate
    - Chemical profile, energy values and nutrient value
      - CDC Nasser and CDC Seabiscuit in comparison with barley grain (CDC Meredith).
- *Study 2:*
  - To investigate
    - Effect of heat processing on oat grains;
  - To compare
    - Different heat processing on oat grains.

OBJECTIVES

MATERIAL AND METHODS

- Study was performed at the Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Canada.

- Grains:
  - Supplied by Crop Development Centre (**CDC**) of U of S;
  - From harvested plots grown in 2013, 2014, and 2015;
  - Were crashed using Sven roller mill with gap to 1.78 mm



MATERIAL AND METHODS

- ***Study 1:***

– Raw **barley** and **oat** grains were crashed using Sven roller mill with gap to 1.78 mm;

– An aliquot was ground using Retsch SM 2000 (Retsch, Inc., Newtown, PA) fitted with a 1.0 mm screen for chemical analyses.

– The remanding was used for *in situ* trial.

MATERIAL AND METHODS

- ***Study 2:***
  - Each **oat variety** was equally divided into 4 portions and each portion was submitted to a different treatment:
    - ✓Raw;
    - ✓Dry heating;
    - ✓Autoclave heating;
    - ✓Microwave irradiation (MIR).
  - Samples were crashed using Sven roller mill with gap to 1.78 mm;
  - Same procedure performed as in Study 1.

MATERIAL AND METHODS

- Conventional rumen ***in situ*** and ***in vitro*** methods were performed to quantify:
  - **Rumen degradation** and **intestinal digestion** of the nutrients;
- Statistical analysis were considering CRBD design performed using PROC MIXED of SAS 9.4:
  - Fixed effect was feed type (*Study 1*) and heat processing (*Study 2*), and each feed sources were used as replications;
  - Multiple treatment comparisons were performed using the Tukey-Kramar test;

- Statistical significance was declared and detected at $P < 0.05$ while trends were declared at $P \leq 0.10$.


CDC Nasser
CDC Seabiscuit
Absorbance
(a)
Absorbance
(b)
2000
1800
1600
1400
1200
1000
800
Wavenumbers (cm-1)

RESULTS

RESULTS

Table 1. Chemical profile and energy values of CDC Nasser (feed oat), CDC Seabiscuit (milling oat) and CDC Meredith (malting barley)

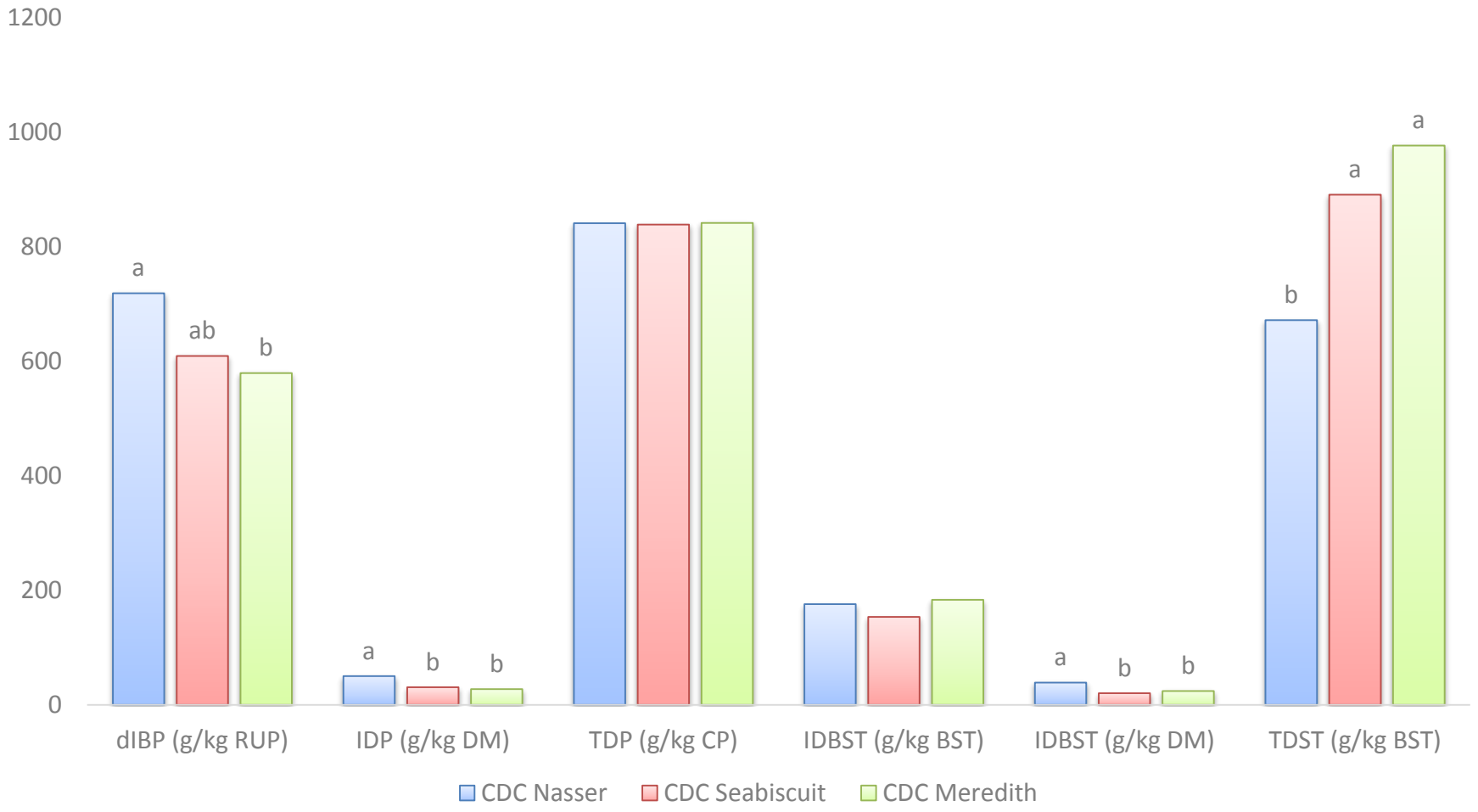
Item[1]	Oat varieties[2]		Control (barley)[2]	SEM[3]	P value	Contrast
	CDC Nasser	CDC Seabiscuit	CDC Meredith			oat vs. barley
Chemical profile						
DM (g/kg)	933.7[a]	933.0[a]	926.3[b]	1.14	0.002	<0.001
OM (g/kg DM)	963.4	966.8	972.3	2.84	0.132	0.070
EE (g/kg DM)	73.0[a]	57.1[a]	26.2[b]	3.35	0.001	<0.001
NDF (g/kg DM)	277.0[a]	286.0[a]	175.3[b]	18.94	0.016	<0.001
ADF (g/kg DM)	168.7[a]	146.3[a]	71.7[b]	10.59	0.001	<0.001
CP (g/kg DM)	111.3	107.7	114.7	5.23	0.418	0.276
SCP (g/kg DM)	30.3	28.3	33.3	3.20	0.232	0.129
Energy values						
TDN_{1x} (g/kg DM)	83.27[ab]	80.40[b]	84.71[b]	0.864	0.024	0.023
DE_{3X} (Mcal/kg DM)	3.34[ab]	3.23[b]	3.41[a]	0.035	0.018	0.017
NE_{L3X} (Mcal/kg DM)	1.90[ab]	1.81[b]	1.91[a]	0.026	0.032	0.069

[1]DM: dry matter; OM: organic matter; EE: ether extract; NDF: neutral detergent fibre; ADF: acid detergent fibre; CP: crude protein, SCP: soluble crude protein; TDN_{1x}: total digestible nutrient at maintenance; DE_{3x}: digestible energy for lactation; NE_{L3x}: net energy for lactation (NRC, 2001)..

[2]Means within a row with different letters differ at the $P < 0.05$ level.

[3]SEM: standard error of mean.

Intestinal and total crude protein (CP) and Intestinal and total starch (ST) digestion



dIDP: intestinal digestibility of bypassed protein; IDP: intestinal digestible of protein on DM basis; TDP: total digestible protein on CP basis; IDBST: intestinal digestible bypassed ST on ST and on DM basis; TDST: total digestible ST on ST basis

RESULTS

Table 2. Effect of heat processing on chemical profile and energy values in comparison of raw (control) in oat grains

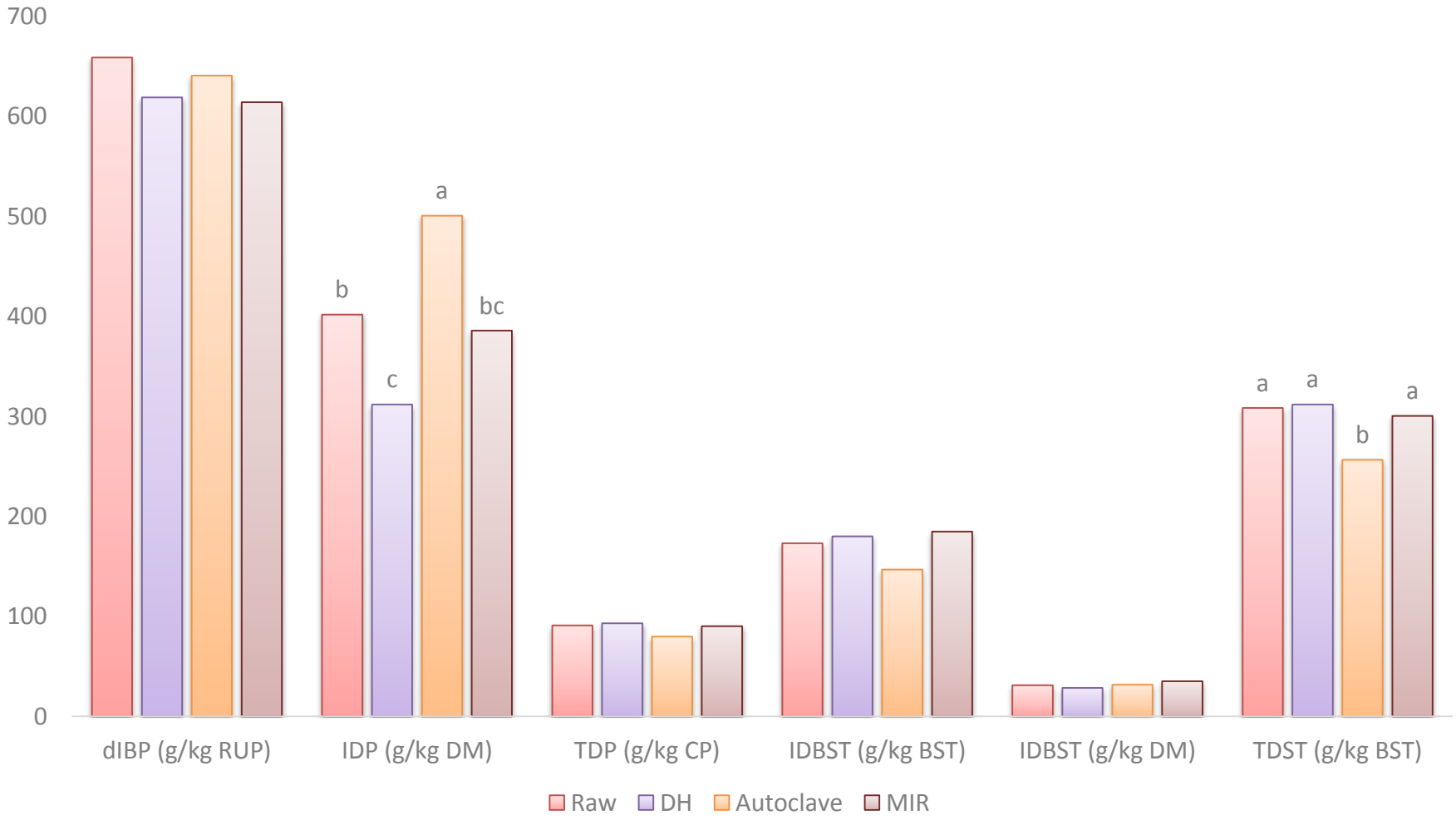
Item[1]	Control (C)[2]	Heat Processing (HP)[2]			SEM[2]	P-value	
	Raw	Dry Heating	Autoclave Heating	Microwave Irradiation		HP *P* value	Contrast (C vs. HP)
Chemical profile							
DM (g/kg)	934.0^{c}	949.7^{a}	929.0^{d}	946.0^{b}	1.20	<0.001	<0.001
OM (g/kg DM)	967.6	960.3	965.3	967.0	2.81	0.329	0.338
EE (g/kg DM)	62.7	55.2	66.6	61.7	2.80	0.107	0.649
CP (g/kg DM)	108.5	110.7	111.7	111.2	7.50	0.314	0.088
SCP (g/kg DM)	27.5^{bc}	38.7^{a}	23.0^{c}	32.0^{ab}	2.53	0.001	0.093
NDF (g/kg DM)	260.2	303.2	271.5	269.7	12.1	0.145	0.167
ADF (g/kg DM)	151.2	154.5	161.5	143.2	4.65	0.119	0.736
Starch (g/kg DM)	460.2	448.7	461.0	457.5	11.6	0.653	0.617
Energy values							
TDN_{1x}(g/kg DM)	827.6	800.1	817.0	823.8	6.21	0.063	0.090
DE_{p3x} (Mcal/kg of DM)	3.32	3.21	3.27	3.31	0.22	0.053	0.087
NE_{L3x} (Mcal/kg of DM)	1.87	1.80	1.84	1.867	0.02	0.069	0.099

[1]DM: dry matter; OM: organic matter; EE: ether extract; NDF: neutral detergent fibre; ADF: acid detergent fibre; CP: crude protein, SCP: soluble crude protein.

[2]Means within a row with different letters differ at the P < 0.05 level.

[3]SEM: standard error of mean.

Intestinal and total crude protein (CP) and Intestinal and total starch (ST) digestion



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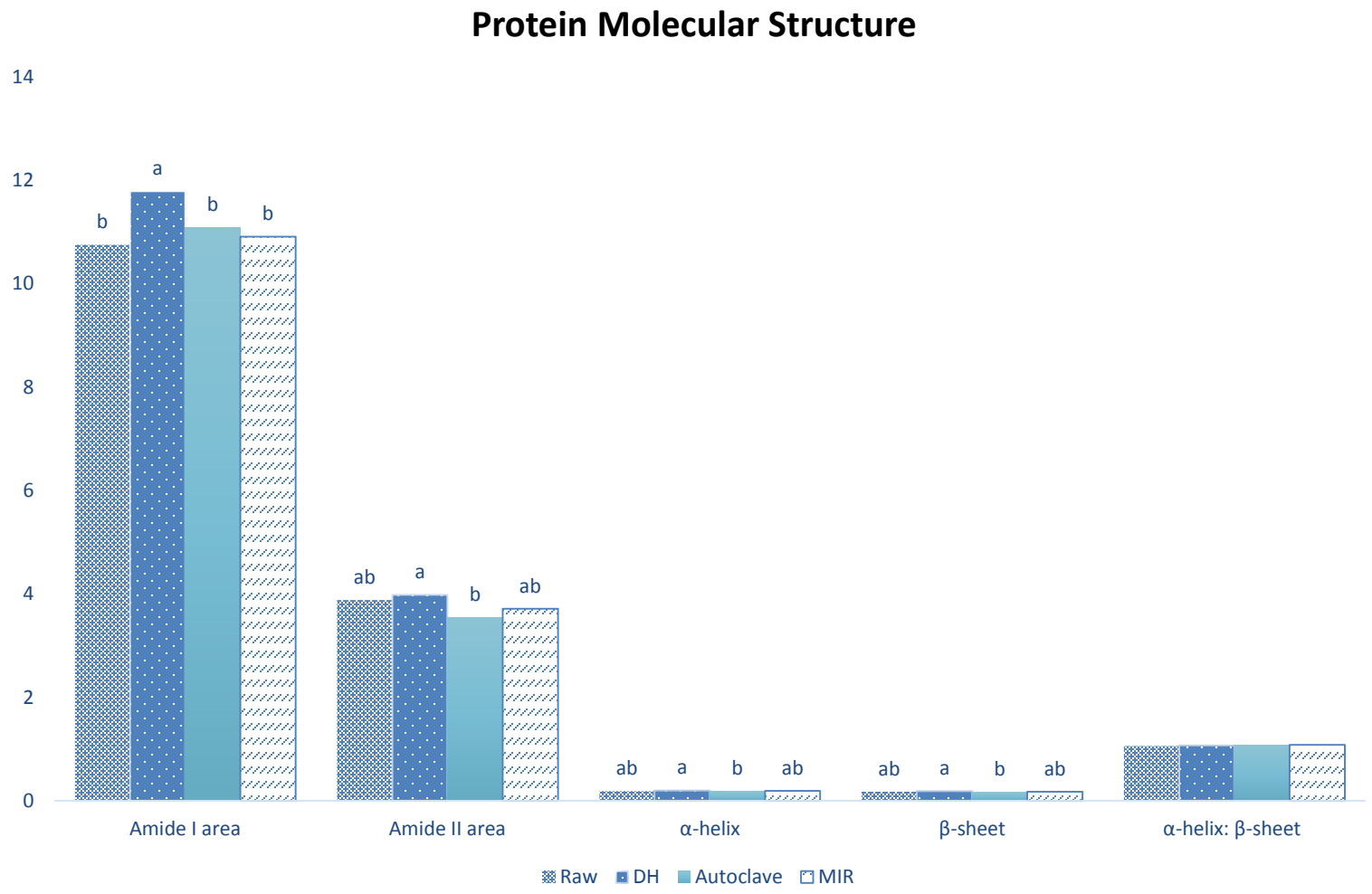
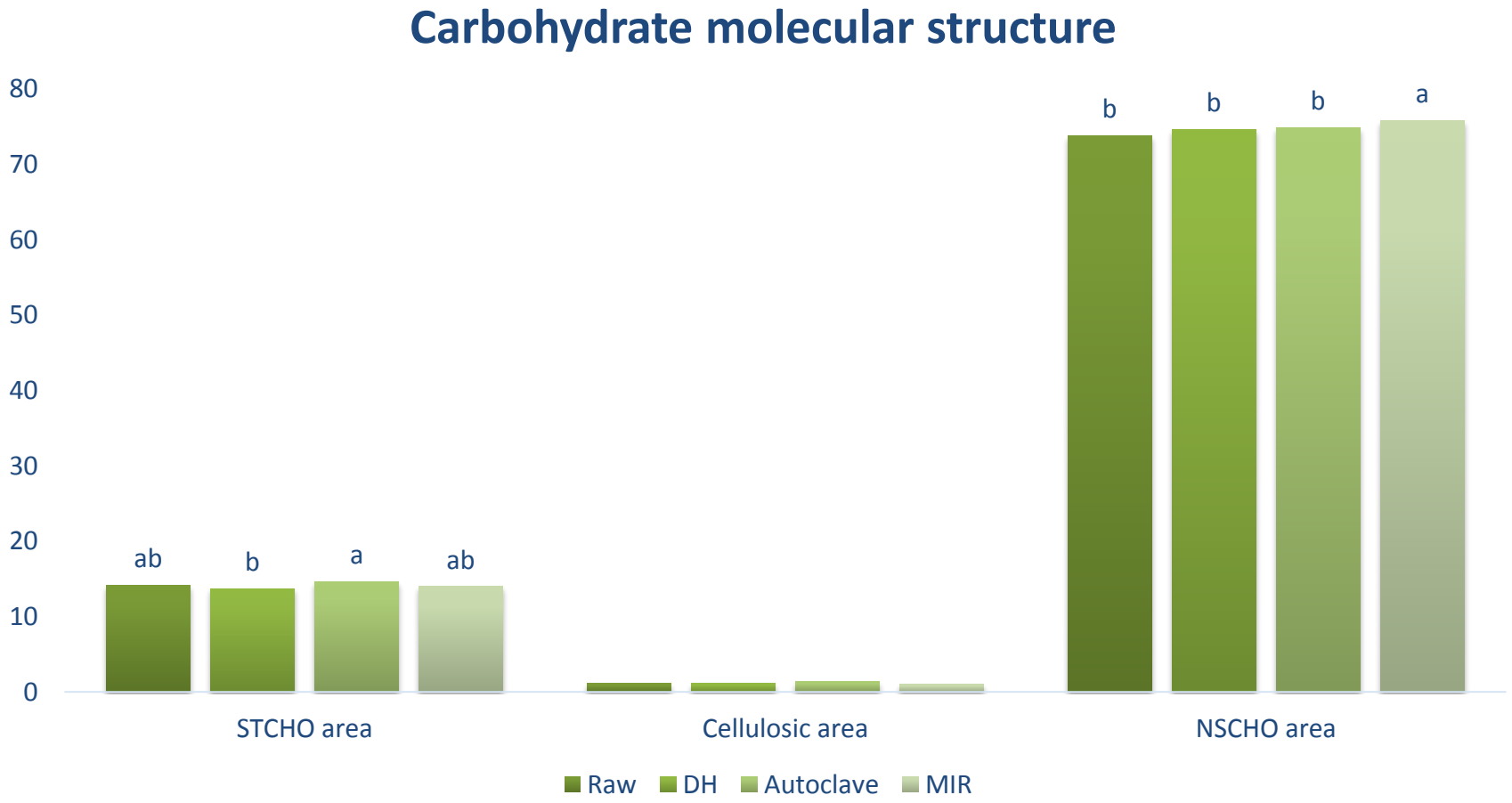
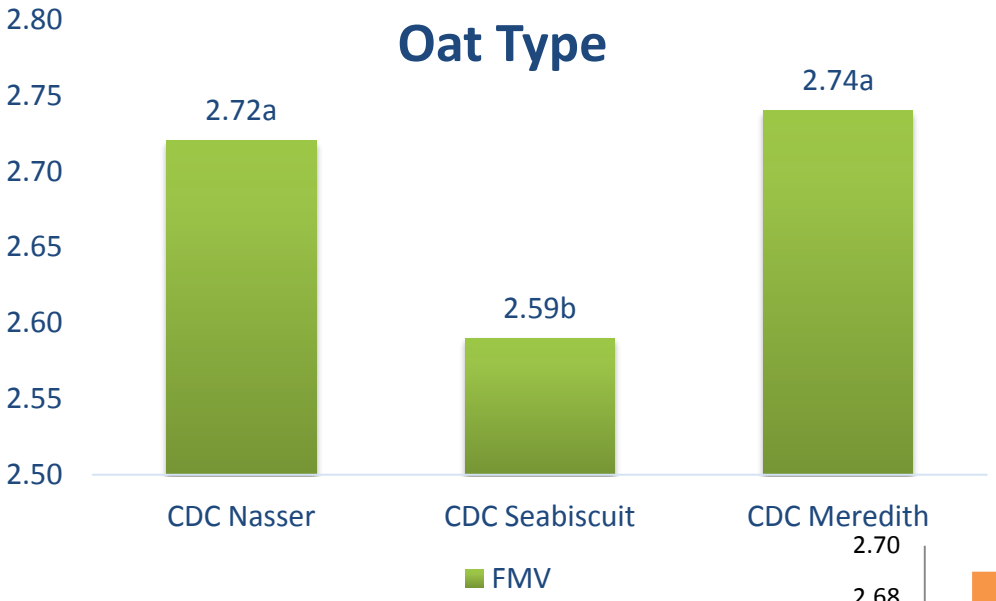
RESULTS

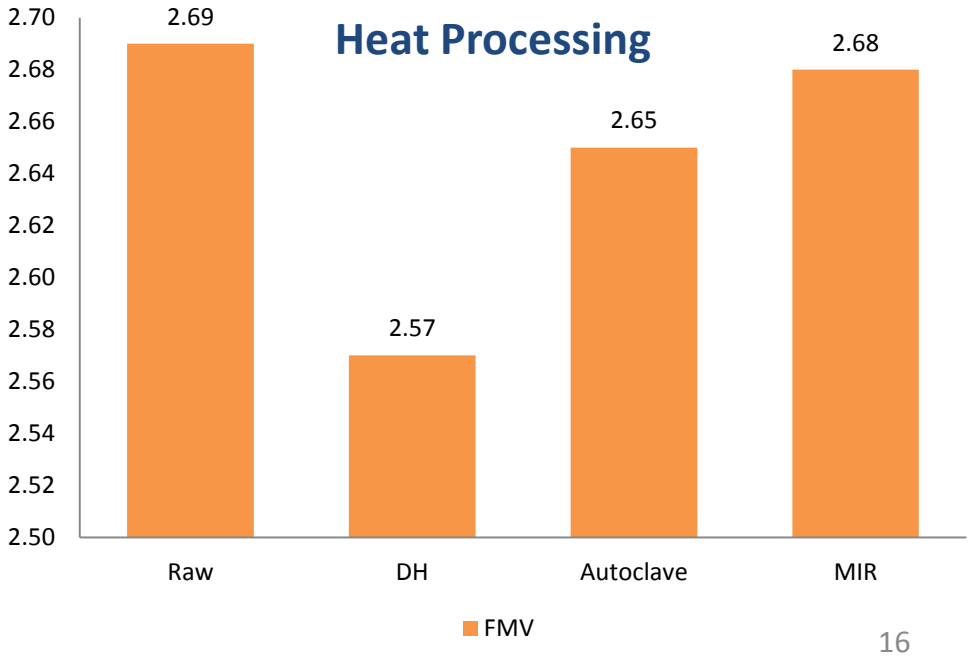

Protein Molecular Structure
14
12
10
8
6
4
2
0
b
a
b
b
ab
a
b
ab
ab
a
b
ab
ab
a
b
ab
Amide I area
Amide II area
α-helix
β-sheet
α-helix: β-sheet
Raw
DH
Autoclave
MIR

RESULTS


Carbohydrate molecular structure
80
70
60
50
40
30
20
10
0
ab
b
a
ab
b
b
b
a
STCHO area
Cellulosic area
NSCHO area
Raw
DH
Autoclave
MIR

Feed milk value (FMV)





- Oat type effect:
  - **CDC Nasser** (feed oat) might be considered as animal feed due to:
    - ✓Greater energy value;
    - ✓Intestinal digestion of protein.
  - **CDC Seabiscuit** (milling oat) provides
    - ✓Greater total digestion of starch.
- Heat processing effect:
  - **Autoclave heating**:
    - ✓May improve the availability of protein to small intestine
  - **Dry heating** and **MIR**:
    - ✓Show greater total digestion of starch

CONCLUSION

Take Home Message

- It is important to ensure a balance diet with the addition of new feeds
- Based on the current study feed and milling oat type can be included in rations for dairy cattle
- The inherent molecular structure can be affected by heat processing
- Alterations provide by heat processing in the inherent molecular structure of grains could explain differences in animal performance

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Thank you…