

()

*

(/ / : / / :)

×

/

(P< /)

(P< /)

(P< /)

:

(Mooney &

.Allen, 1997)

pH

.(Grant et al., 1990; Teimouri Yansari et al., 2004)

.(NRC, 2001)

(1997) Grant .

Mertens .(Mertens, 1997)
(PeNDF) (1997)

pH

Poppi et al. . (1985)

Mertens . / (1997)

)
± (/ ± ±
×
()

.(Firkins, 1997)

(2004) Kaps & Lamberson

.(Akinoyode et al., 2000)

pH

(Hsu et al., 1987;
Akinoyode et al., 2000; Teimouri Yansari et al.,
(1994) Weidner & Grant .2004)

/

()
()
()

pH

(1997) Mooney & Allen

(Grant et al.,

.1990; Shaver et al., 1988)

(1998) SAS

$$y_{ijkl} = \mu + A_i + B_j + AB_{ij} + P_k + cow_l + e_{ijkl}$$

(i =)

(j =)

(k =)

(l = ...)

PDIFF

P < /

(P < /)

(P < /)

() ()

CPM-Dairy

() ()

AOAC

(NDF)

(1990)

Van Soest et al.

(ADF)

(1991)

| | | |
|---|---|---------|
| / | | (%) |
| / | / | (%) |
| / | / | (%) |
| / | / | (%) NDF |
| / | / | (%) ADF |
| / | / | (%) |
| / | / | (%) |
| / | / | (%) |

(Kononoff et al., 2003)

(2001) ASAE

$$PeNDF \% = (DM \% > 19 \text{ mm} \times NDF \% > 19 \text{ mm}) + (DM \% > 8 \text{ mm} \times NDF \% > 8 \text{ mm}) + (DM \% > 1.18 \text{ mm} \times NDF \% > 1.18 \text{ mm})$$

1. Cornell Pennsylvania Miner Dairy Software
2. Pennsylvania Particle Size Separator

| I | APS | FS | SEM | | | | | |
|-----|-----|----|------------|---|---|---|---|-----|
| () | | | | | | | | |
| / | * | / | / | / | / | / | / | < |
| / | ** | ** | / | / | / | / | / | |
| / | / | / | / | / | / | / | / | / |
| / | ** | ** | / | / | / | / | / | < / |
| / | ** | / | / | / | / | / | / | Xgm |
| / | / | / | / | / | / | / | / | Sgm |
| () | | | | | | | | |
| | | | | / | / | / | / | < |
| | | | | / | / | / | / | |
| | | | | / | / | / | / | / |
| / | * | ** | / | / | / | / | / | () |
| | | | : FS × APS | : | : | : | : | : |
| | | | : / | : | : | : | : | :* |

Kononoff & Heinrichs

(2000) Akinyode et al. (2003)

(Grant et al.,1990;

Shaver et al., 1988; Teimouri Yansari et al., 2004)

(Akinyode et al., 2000; Kononoff & Heinrichs, 2003)

.()

.(P< /)

(2004) Teimouri Yansari et al. (1990) Grant et al.

(1999) Le Liboux & Peyraud .

Beauchemin et al. .

(1997)

(/)

(Soita et al., 2000)

.(P< /)

(1990) Grant et al.

(2004) Teimouri Yansari et al.

.(P= /)

(/)

(P < /)

(Clark & Armentano 1997; Kononoff & Heinrichs, 2003; Mooney & Allen, 1997)
(2003) Kononoff & Heinrichs

| I | APS | FS | SEM | | | | | | |
|---|-----|----|-----|---|---|---|---|---|-----|
| / | / | / | / | / | / | / | / | / | () |
| / | / | / | / | / | / | / | / | / | () |
| / | / | / | / | / | / | / | / | / | (%) |
| / | / | / | / | / | / | / | / | / | (%) |
| / | / | / | / | / | / | / | / | / | () |

:FS × APS :I :APS :FS
:FCM

| I | APS | FS | SEM | | | | | | |
|---|-----|----|-----|---|---|---|---|---|-----|
| / | / | / | / | / | / | / | / | / | |
| / | * | ** | / | / | / | / | / | / | |
| * | * | ** | / | / | / | / | / | / | NDF |
| / | / | / | / | / | / | / | / | / | |
| / | / | / | / | / | / | / | / | / | |
| / | / | ** | / | / | / | / | / | / | NDF |
| / | / | / | / | / | / | / | / | / | |
| / | * | * | / | / | / | / | / | / | |
| / | * | ** | / | / | / | / | / | / | NDF |

:FS × APS :I :APS :FS
:*** / :*

REFERENCES

1. Akinyode, A. M., Hall, M. B., Staples, C. R., Head, H. H. & Kunkle, W. E. (2000). Effects of cottonseed hulls in the diets of dairy cows. *Journal of Dairy Science*, 83 (Suppl. 1), 296. (Abstract)
2. Allen, M. S. (2000). Effects of diet on short-term regulation of feed intake by lactating dairy cattle. *Journal of Dairy Science*, 83, 1598–1624.
3. AOAC. (1990). *Official Methods of Analysis*, Arlington, V.A., U.S.A.
4. ASAE. (2001). Method of determining and expressing particle size of chopped forage materials by sieving. S424, Standards American Society of Agricultural Engineering, Page 562.
5. Beauchemin, K. A., Rode, L. M. & Eliason, M. J. (1997). Chewing activities and milk production of dairy cows fed alfalfa as hay, silage, or dries cubes of hay or silage. *Journal of Dairy Science*, 80, 324–333.
6. Clark, P. W. & Armentano, L. E. (1997). Influence of particle size on the effectiveness of beet pulp fiber. *Journal of Dairy Science*, 80, 898 - 904.
7. Firkins, J. L. (1997) Effects of feeding nonforage fiber sources on site of fiber digestion. *Journal of Dairy Science*, 80, 1426–1437.
8. Grant, R. J. (1997). Interaction among forage and nonforage fiber sources. *Journal of Dairy Science*, 80, 1438–1446.
9. Grant, R. J., Colenbrander, V. F. & Mertens, D. R. (1990). Milk fat depression in dairy cows: role of particle size of alfalfa hay. *Journal of Dairy Science*, 73, 1823–1833.
10. Hsu, J. T., Faulkner, D. B., Garleb, K. A., Barclay, R. A., Fahey, G. C. & Berger, L. L. (1987). Evaluation of corn fiber, cottonseed hulls, oat hulls and soybean hulls as roughage sources for ruminants. *Journal of Animal Science*, 65, 244–255.
11. Kaps, M. & Lamberson, W. R. (2004). *Biostatistics for animal science*, United Kingdom: CABI Publishing Company.
12. Kononoff, P. J. & Heinrichs, A. J. (2003). The effect of corn silage particle size and cottonseed hulls on cows in early lactation. *Journal of Dairy Science*, 86, 2438–2451.
13. Kononoff, P. J., Heinrichs, A. J. & Buckmaster, D. A. (2003). Modification of the pennstate forage and TMR separator and the effects of moisture content on its measurements. *Journal of Dairy Science*, 86, 1858–1863.
14. Le Liboux, S. & Peyraud, J. L. (1999). Effect of forage particle size and feeding frequency on fermentation patterns and sites and extent of digestion in dairy cows fed mixed diets. *Animal Feed Science and Technology*, 76, 297–319.
15. Mertens, D. R. (1997). Creating a system for meeting the fiber requirements of dairy cattle. *Journal of Dairy Science*, 80, 1463–1482.
16. Mooney, C. S. & Allen, M. S. (1997). Physical effectiveness of the neutral detergent fiber of whole linted cottonseed relative to that of alfalfa silage at two lengths of cut. *Journal of Dairy Science*, 80, 2052–2061.
17. NRC. (2001) *Nutrient requirements of dairy cattle*. (7th ed.) National Academy of Science, Washington, DC, U.S.A.
18. Palmquist, D. L. & Conrad, H. R. (1978). High fat rations for dairy cows: effects on feed intake, milk and fat production and plasma metabolites. *Journal of Dairy Science*, 61, 890–901.
19. Poppi, D. P., Hendrickson, R. E. & Minson, D. J. (1985). The relative resistance to escape of leaf and stem particles from the rumen of cattle. *Journal of Agricultural Science*, 105, 9–14.
20. SAS. (1998) *User's guide: statistics*. Version 8.2. SAS Institute, Cary, NC, U.S.A.
21. Schwab, E. C., Shaver, R. D., Shinnors, K. J., Lauer, J. G. & Coors, J. G. (2002). Processing and chop length effects in brown-midrib corn silage on intake, digestion, and milk production by dairy cows. *Journal of Dairy Science*, 85, 613 - 623.
22. Shaver, R. D., Nytes, A. J., Satter, L. D. & Jorgenson, N. A. (1988). Influence of feed intake, forage physical form and forage fiber content on particle size of masticated forage, ruminal digesta and feces of dairy cows. *Journal of Dairy Science*, 71, 1566–1577.
23. Soita, H. W., Christensen, D. A. & McKinnon, J. J. (2000). Influence of particle size on the effectiveness of the fiber in barley silage. *Journal of Dairy Science*, 83, 2295 - 2300.
24. Stockdale, C. R. & Beavis, G. W. (1994). Nutritional evaluation of whole plant maize ensiled at three chop lengths and fed to lactating dairy cattle. *Australian Journal of Experimental Science*, 34, 709–716.
25. Teimouri Yansari, A., Valizadeh, R., Naserian, A., Christensen, D. A., Yu P. & Eftekhari Shahroodi F. (2004). Effects of alfalfa particle size and specific gravity on chewing activity, digestibility, and performance of Holstein dairy cows. *Journal of Dairy Science*, 87, 3912–3924.
26. Torren, J., Johnson, D. E. & Kujawa, M. A. (1994). Co-product fiber digestibility: kinetic and in vivo assessment. *Journal of Animal Science*, 72, 790–800.
27. Van Horn, H. H., Harris, B., Taylor, M. J., Bachman, K. C. & Wilcox, C. J. (1984). By-product feeds for lactating dairy cows: effects of cottonseed hulls, sunflower hulls, corrugated paper, peanut hulls, sugarcane

- bagasse and whole cottonseed with additives of fat, sodium bicarbonate and aspergillus oryzae product on milk production. *Journal of Dairy Science*, 67,2922–2938.
28. Van Soest, P. J., Robertson, J. B. & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and non starch polysaccharide in relation to animal nutrition. *Journal of Dairy Science*, 74, 3583-3597.
 29. Varga, G. A., Dann, H. M. & Ishler, V. A. (1998). The use of fiber concentration for ration formulation. *Journal of Dairy Science*, 81, 3063-3074.
 30. Weidner, S. J. & Grant, R. J. (1994) Altered ruminal mat consistency by high percentages of soybean hulls fed to lactating dairy cows. *Journal of Dairy Science*, 77, 522-532.
 31. Yang, W. Z., Beauchemin, K. A. & Rode, L. M. (2002) Effects of particle size of alfalfa based dairy cow diets on site and extent of digestion. *Journal of Dairy Science*, 85, 1958–1968.