*Tropical Animal Production* 1984 9:264-270

# SODIUM HYDROXIDE AND AMMONIA TREATED WHEAT STRAW IN DIETS FOR GROWING RABBITS

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In experiments to evaluate alkali treated wheat straw, 24 weaned Californian rabbits (weight 1.17 kg) were fed ad libitum either untreated, sodium hydroxide (NaOH) treated or ammonia ($NH_4OH$) treated wheat straw. A restricted level of pelleted concentrate supplement was offered to all animals. Over 37 d dry matter (DM) consumption of straw (0.17 ± 0.03 kg) was very low compared with that of pelleted concentrate (3.11 ± 0.09) for all treatments. In a second experiment, 18 weaned Californian rabbits (weight 1.11 kg) were fed one of three complete pelleted diets containing 50% wheat straw (either untreated or treated with NaOH or $NH_4OH$) and 50% concentrate supplement. Average daily weight gain (22.6 ± 1.1 g) did not differ between diets. Rabbits on NaOH treated straw diet had better feed conversion ratio, killing out % and digestibility. Ammonia treated straw showed no improvement over untreated straw.

Key words: Rabbits, treated straw, liveweight gain, sodium hydroxide, ammonia

Rabbits digest poorly the fibrous component of feedstuffs (Aitkin and Wilson 1962; Voris et al 1940; Spreadbury 1975; Partridge 1980; Udén and Van Soest 1982; Slade and Hintz 1969; Cheeke 1981). One way to improve digestibility of roughage is to treat it chemically with sodium hydroxide or ammonia. Such treatments have been frequently used for upgrading straw for ruminants.

The objectives of this experiment were to investigate: (a) the acceptability by growing rabbits of diets containing treated straw; (b) performance when treated straw formed part of their diet. In experiment 1 straw was chopped and offered loose in racks with a restricted level of concentrate supplement. In a second experiment rabbits were offered a complete pelleted diet containing 50% milled wheat straw, either untreated or treated with sodium hydroxide (NaOH) or ammonia solution ($NH_4OH$), and 50% concentrate.

## Materials and Methods

*Preparation of treated straw:* Chopped (20-40 mm) wheat straw (850g dry matter (DM)/kg) was used. For NaOH treatment, 5.0 kg batches were treated with 3.03 kg NaOH solution (60 g/kg) and hand mixed for 20 minutes. For $NH_4OH$ treatment, 3.0 kg batches were treated with 0.26 kg $NH_3$ solution (350 g/kg) in polythene bags. NaOH and $NH_4OH$-treated straws were stored in sealed polythene bags for 40 days. Before use the straws were oven-dried at 85°

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for 24 h. In experiment 1 straw was chopped; in experiment 2 it was milled (2mm screen)and incorporated into a complete pelleted diet (9 mm diameter, 10-15 mm lengths) at the 50% inclusion level.

*Chemical analysis:* Feed components and diets were analysed (Table 2) for proximate constituents (AOAC 1970), cell wall components (Goering and Van Soest 1970), in vitro digestibility using rumen liquor (Tilley and Terry 1963) and gross energy content (Gallenkamp adiabatic bomb calorimeter).Faeces were freeze-dried before analysis.

*Experimental design and procedures:* Both experiments were conducted under simulated tropical conditions of 25°ambient temperature and 12 h day length; humidity varied between 40 and 80 RH. Experiment 1 involved 24, forty five-day old, weaned, male, Californian rabbits allocated at random to one of three treatments; experiment 2 involved 18, forty six-day old, weaned Californian rabbits of both sexes, allocated at random to one of three diets after blocking for sex (Table 1). All rabbits were individually caged. Feed and water were available ad libitum (except pelleted concentrate supplement in experiment 1, which was restricted at 115 g/d) until slaughter at 2 kg liveweight. Feed consumption and live weight were recorded twice weekly (Table 3 and Table 5). During the trials each rabbit was placed in a metabolism crate for a 7-day collection period to determine diet digestibility. Feed consumption and faeces were recorded daily.

*Table 1:*
*Composition of diets* (g/kg)

| Ingredient | Experiment 1 (Concentrate supplement) | Experiment 2 (Complete pelleted diet) |
|---|---|---|
| Barley | 275 | 138 |
| Extracted soya bean meal | 570 | 285 |
| Dicalcium phosphate | 15 | 7 |
| Salt | 2 | 1 |
| Molasses | 50 | 25 |
| Methionine | 4 | 2 |
| Vitamin-mineral premix | 50 | 25 |
| Soya oil | 34 | 17 |
| Wheat straw* | 0 | 500 |

* In Experiment 2 the wheat straw was either untreated or treated with sodium hydroxide or ammonia

Table 2:
*Chemical analysis of diets (g/kg dry matter)*

| Analysis | Experiment 1 | | | | Experiment 2 | | |
|---|---|---|---|---|---|---|---|
| | Concentrate supplement | Untreated straw | NaOH straw | $NH_4OH$ straw | Untreated straw diet | NaOH straw diet | $NH_4OH$ straw diet |
| Dry matter | 868 | 911 | 890 | 909 | 889 | 897 | 884 |
| Ash | 108 | 63 | 108 | 59 | 84 | 108 | 83 |
| pH | 6.2 | 7.2 | 9.8 | 6.2 | 5.8 | 8.0 | 5.8 |
| Crude protein | 308 | 41 | 41 | 88 | 160 | 165 | 194 |
| Ether extract | 44 | 10 | 9 | 11 | 32 | 29 | 35 |
| Crude fibre | 52 | 445 | 434 | 452 | 248 | 241 | 250 |
| Neutral detergent fibre | na | 840 | 687 | 809 | 506 | 460 | 498 |
| Acid detergent fibre | 88 | 580 | 564 | 593 | 349 | 334 | 345 |
| Cellulose | 59 | 412 | 330 | 426 | 254 | 245 | 256 |
| Lignin | 27 | 136 | 214 | 135 | 80 | 76 | 76 |
| Gross energy (MJ/kg) | 18.73 | 18.63 | 17.67 | 18.55 | 18.62 | 18.20 | 18.67 |
| In vitro digestibility[a] of | | | | | | | |
| Organic matter % | 89.0 | 42.7 | 75.5 | 58.9 | | | |

[a] Tilley & Terry 1963

na = not analysed

## Results and Discussion

*Experiment 1:* All rabbits completed the trial and there were no observable health problems. There were no significant differences ($P < .05$) between treatments for growth, feed consumption and slaughter parameters (Table 3). This was mainly due to the low consumption of the straw both untreated and treated and a correspondingly high consumption of the concentrate supplement which was common to all rabbits (approximately 5% straw:95% concentrate supplement). Thus any differences due to different forms of chopped straw were masked by the dominant effect of the pelleted concentrate portion of the diet. This experiment showed it was impractical to feed chopped straw to rabbits. Results from the digestibility trial (Table 4) indicated a higher digestibility ($P < .05$) for dry matter, gross energy and acid detergent fibre for NaOH treatment compared with $NH_4OH$ treatment.

*Table 3:*
*Mean values for growth, feed consumption and slaughter data (Experiment 1)*

| Diets | Untreated | NaOH | $NH_4OH$ | SE diff |
|---|---|---|---|---|
| Initial weight, kg | 1.17 | 1.15 | 1.18 | 0.07 |
| Age at 2 kg live weight, d | 82 | 82 | 81 | 0.52 |
| Weight gain, d | 29.96 | 27.10 | 28.72 | 1.54 |
| Concentrate intake, kg DM | 3.11 | 3.05 | 3.16 | 0.09 |
| Straw intake, g DM | 168 | 144 | 201 | 30 |
| Feed conversion ratio, kg feed DM/kg gain | 3.02 | 3.27 | 3.26 | 1.84 |
| Slaughter weight, kg | 2.26 | 2.09 | 2.22 | 0.25 |
| Hot carcass weight, kg | 1.18 | 1.11 | 1.17 | 0.05 |
| Killing out %* | 56.5 | 57.1 | 57.2 | 0.95 |
| Weight of gut contents, g | 178 | 180 | 175 | 23.1 |

* Killing out % = $\frac{\text{carcass weight}}{\text{(slaughter weight - gut contents)}} \times 100$

*Experiment 2:* All rabbits completed the trial with no observable health problems. There were no significant sex effects or sex x diet interactions and only main effects (diets) are shown in Tables 5 and 6. Rabbits grew equally well on all three diets. Total DM consumption was greater ($P < .01$) on the untreated straw diet. Rabbits on the NaO-treated straw diet had the best feed conversion ($P < .01$). Rabbits on NaOH-treated straw diet had a significantly ($P < .05$) heavier hot carcass weight compared with those on the $NH_4OH$-treated straw. Killing out percent differed ($P < .001$) according to diet and was best for NaOH and poorest for $NH_4OH$ treated straw.

*Table 4:*
*Results of digestibility trial (Experiment 1)*

| Diets | Untreated | NaOH | $NH_4OH$ | SE diff |
|---|---|---|---|---|
| Number of replicates | 8 | 8 | 8 | |
| Dry matter intake, g | 558 | 505 | 553 | 29.3 |
| Concentrate | 558 | 505 | 553 | 29.3 |
| Straw | 30 | 23 | 37 | 6.97 |
| Digestibility, % | | | | |
| Dry matter | $76^{ab}$ | $78^{a}$ | $74^{b}$ | 0.96 |
| Organic matter | 79 | 78 | 77 | 1.00 |
| Gross energy | $79^{ab}$ | $81^{a}$ | $78^{b}$ | 0.96 |
| Crude protein | 82 | 82 | 81 | 1.02 |
| Acid detergent fibre | $35^{ab}$ | $38^{a}$ | $28^{b}$ | 4.08 |
| Digestible energy, MJ/kg DM | 15 | 15 | 15 | 0.25 |

Notes: $^{a,b}$Row means with different superscripts are significantly different ($P < 0.05$)

*Table 5:*
*Mean values for growth, feed consumption and slaughter data (Experiment 2)*

| Diets | Untreated | NaOH | $NH_4OH$ | SE diff |
|---|---|---|---|---|
| Initial live weight, kg | 1.09 | 1.10 | 1.13 | 0.23 |
| Age at 2 kg live weight, d | 88 | 88 | 88 | 0.24 |
| Weight gain, d/d | 22.6 | 24.46 | 20.6 | 1.06 |
| Total feed intake, kg DM | $5.74^{b}$ | $4.87^{a}$ | $5.17^{a}$ | 0.21 |
| Feed conversion, kg feed DM/kg gain | $6.07^{b}$ | $4.78^{a}$ | $5.97^{b}$ | 0.24 |
| Slaughter weight, kg | 2.04 | 2.13 | 2.00 | 0.08 |
| Hot carcass weight, kg | $1.03^{ab}$ | $1.10^{b}$ | $0.97^{a}$ | 0.04 |
| Weight of gut contents, g | 229 | 227 | 235 | 17.1 |
| Killing out % | 56 | 58 | 55 | 0.53 |

In general, rabbits on the NaOH straw performed better. There was little difference between the untreated and $NH_4OH$ straw. The digestibility trial (Table 6) indicated that rabbits digested best the DM, organic matter and gross energy of the NaOH straw diet.

The rabbits in experiment 1 had a better DM feed conversion than those in experiment 2 due to lower consumption of diets with a much higher digestible energy content. The higher growth rates in experiment 1 also contributed to the better feed conversion.

*Table 6:*
*Diet digestibility (Experiment 2)*

| Diets | Untreated | NaOH | $OH_4OH$ | SE diff |
|---|---|---|---|---|
| Number of replicates | 6 | 6 | 6 | |
| Digestibility, % | | | | |
| Dry matter | 39 | $50^{b}$ | $43^{a}$ | 2.01 |
| Organic matter | 46 | 56 | 50 | 2.50 |
| Gross energy | 46 | 56 | 50 | 2.47 |
| Crude protein | 71 | 75 | 75 | 3.08 |
| Acid detergent fibre | 20 | 27 | 23 | 3.73 |
| Digestible energy, MJ/kg DM | $8.63^{a}$ | $10.2^{b}$ | $9.34^{ab}$ | 0.45 |

$^{a,b}$ Row means with different superscripts are significantly different
There were no significant sex effects or sex x diet interactions.

These experiments indicate that alkali-treated straw can be included in the diets of growing rabbits, but that such straw must be incorporated as part of a complete pelleted diet to ensure adequate voluntary intake. At the level reported in experiment 2 (500 g/kg), feed conversion ratio, diet digestibility and carcass weight were better for straw treated with NaOH compared with untreated straw. By contrast, ammonia treatment did not improve performance despite an apparently higher nutritive value as measured in vitro using rumen liquor. De Blas et al (1979) reported improved growth rates, feed conversion and digestibilities for nitrogen and fibre as the content of sodium hydroxide treated straw in the feed was raised to a maximum of 150 g/kg. Lindeman et al (1982) observed that up to 300 g/kg sodium hydroxide treated straw could be included in pelleted diets for rabbits without detrimental effects on performance, but that the inclusion of 80 g/kg untreated ground straw compared with 80 g/kg NaOH treated straw had a growth depressing effect.

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*Received July 6, 1983.*