

Development of new functional feed that utilizes Yacon (*Smallanthus sonchifolius*) and Rush (*Juncus effuses* L.) in Japan

Akiko Koike^A, Shin Yasuda^B, Ryoji Nagai^B, Chinobu Okamoto^B, Takahiro Nikki^B, Keiji Igoshi^B, Rajeev Pradhan^B, Masateru Ono^B and Kiyotaka Kabata^B

^A Akita Prefectural University, Faculty of Bioresource Sciences, Akita, Japan

^B Tokai University, Faculty of Agriculture, Kumamoto, Japan

Contact email: akoike@akita-pu.ac.jp

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Introduction

Yacon (*Smallanthus sonchifolius*) is acknowledged as a food as well as a medicinal plant and its cultivation in Japan has recently expanded. Rush (*Juncus effuses* L.) which is widely distributed in the temperate regions in the northern hemisphere, has historically been used as a herbal medicine for nephritis and dermal disorders. However, there is a lot of harvest residue of both plants. This research was conducted to find out the way for the effective use of these residues as functional feed resources.

Materials and Methods

Feeding experiments

These experiments were carried out at Tokai University, Japan (32°55'N, 131°6'E). In Experiment 1 the above ground parts of Yacon were ensiled with 20% wheat bran (YS). Suffolk ewes aged 4 to 6 years and weighing 45 kg ± 8.4 kg were divided into YS group and Bermuda grass hay (BH) group (n=3/group) and fed diets comprised of either 60% YS or BH with 40% soybean curd residue silage *ad libitum*. The influence of physical stress (necks tied with rope to restrict movement, collection of gastric juice) on the ewes was examined by urinary 8-hydroxydeoxyguanosine (8-OHdG) as a maker using an 8-OHdG ELISA assay (Toyokuni *et al.* 1997). Urine samples were collected before (0 day) and after (20 days later) the mending stress burden, respectively. In Experiment 2, Rush was dried and powdered (RP). Berkshire pigs aged 3 – 4 months and weighing approximately 40 kg were divided into RP and control groups (n=3/ group) and fed a commercial concentrate diet *ad libitum*; the RP group was supplemented 0.05% RP. Pigs were used to evaluate RP, measured the amount of coliform bacillus bacteria in collected fecal material, which was also used to measure the malodorous component (hydrogen sulfide) with gas detecting tubes.

Analysis of Functionality

The antioxidative activities of YS and RP (5 registered cultivars) were evaluated using the ferric thiocyanate method (Masuoka *et al.* 2003) and DPPH radical scavenging activity using the standard method (Furuta *et al.* 2003). Phenolic content of RP was measured using the standard method (Furuta *et al.* 2003). The effect of Rush on the formation of

N^o-carboxymethylarginine (CMA), one of major advanced glycation end products (AGEs) in glycated gelatins, was estimated using an ELISA assay which quantified spectrophotometrically by absorbance at 492 nm. The ELISA method using monoclonal antibodies specific to CMA was established as described previously (Shimasaki *et al.* 2011). AGEs is generated by an oxidization denaturation of protein, and its accumulation increases by onset of lifestyle-related diseases. Therefore, the AGEs generation inhibiting effect can expect the effect which controls lifestyle-related diseases (in domestic animals, abnormalities in sugar metabolism).

Results

YS and RP showed high anti-oxidative activity. YS was highly palatable when fed to ewes. Moreover, the amount of urinary 8-OHdG (Fig. 1) showed a lower tendency in the YS group than in the BH group in the ewe feeding experiment. In RP group, hydrogen sulfide concentration and the amount of coliform bacillus bacteria were reduced compared to those of control group. It is suggested that RP regulated the function of intestines of pigs. Furthermore, gelatin was incubated with ribose at 37°C for 7 days, and CMA formation was measured by ELISA. As shown in Figure 2, CMA was observed after 7 days incubation (control), whereas luteolin, used as a positive control, showed a strong inhibitory effect of CMA formation. Under the same assay conditions, all Rush extracts inhibited CMA formation as could be seen from lower absorbance values than control. We have identified that Rush contains luteolin and

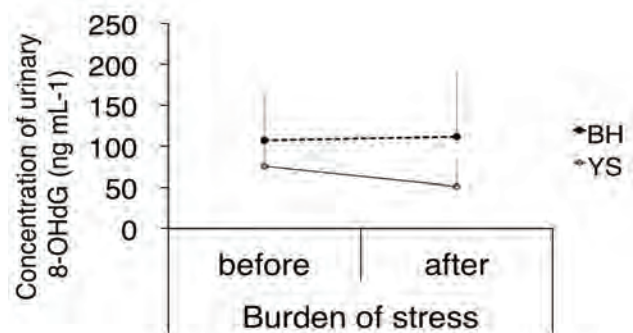


Figure 1. The change in ewe 8-OHdG concentration before and after stress in the YS and BH group (n=3 group).

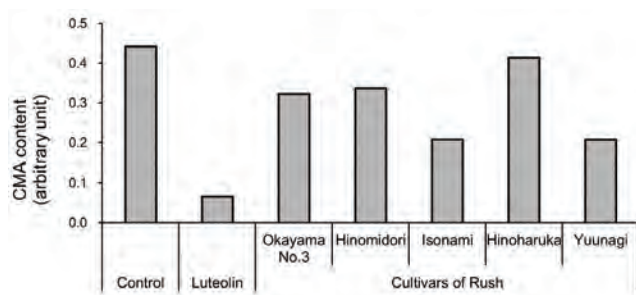


Figure 2. Inhibition activities of CMA formation of Rush extracts: CMA measured by absorbance at 492nm.

its glycoside (unpublished data) which inhibited CMA formation.

Conclusion

From the results, it is suggested that Yacon silage and Rush powder are useful feed supplements for ruminants and

monogastric animals with possible health promoting effects. Further research is required to examine constituent functions in more detail.

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