

Table S1. Nutritional composition of RY4.

Items	RY4
DM (% , FM)	17.4
CP (% , DM)	10.3
EE (% , DM)	2.4
NDF (% , DM)	58.8
ADF (% , DM)	35.6
Ash (% , DM)	12.8

FM, Fresh weight;DM, Dry weight.

Table S2. Principal Factor Loading Matrix

Index	Factor loading	
	F1	F2
SDW (x ₁)	0.901	-0.12
RDW (x ₂)	0.605	-0.362
NDW (x ₃)	0.559	-0.565
NON (x ₄)	0.837	-0.265
CP (x ₅)	0.838	-0.022
PP (x ₆)	0.937	-0.127
EE (x ₇)	0.558	0.61
NDF (x ₈)	-0.547	0.234
ADF (x ₉)	0.124	0.528
Ash (x ₁₀)	-0.364	-0.179
IVDMD (x ₁₁)	-0.437	-0.401
NH ₃ -N (x ₁₂)	0.576	0.257
MCP (x ₁₃)	0.461	0.001
Acetate (x ₁₄)	0.18	0.762
Propionate (x ₁₅)	0.022	0.826
TVFA (x ₁₆)	0.305	0.595

Principal component scoring equation:

$$Y_1 = 0.388X_1 + 0.261X_2 + 0.241X_3 + 0.360X_4 + 0.361X_5 + 0.404X_6 + 0.240X_7 - 0.236X_8 + 0.053X_9 - 0.157X_{10} - 0.188X_{11} + 0.248X_{12} + 0.199X_{13} + 0.078X_{14} + 0.009X_{15} + 0.131X_{16}$$

$$Y_2 = -0.068X_1 - 0.205X_2 - 0.319X_3 - 0.150X_4 - 0.012X_5 - 0.072X_6 + 0.345X_7 + 0.132X_8 + 0.298X_9 - 0.101X_{10} - 0.227X_{11} + 0.145X_{12} + 0.001X_{13} + 0.431X_{14} + 0.467X_{15} + 0.336X_{16}$$

$$Y_3 = 0.337 Y_1 + 0.196 Y_2$$

Table s3. *In vitro* fermentation gas production (ml/g).

	2h	4h	8h	12h	24h	36h	48h	72h
RY4	19.3 ± 3.0a	22.7 ± 3.1	27.6 ± 2.5a	34.2 ± 2.5	44.2 ± 1.9ab	70.7 ± 5.2	94.9 ± 5.6a	108.7 ± 6.0
CK + RY4	13.0 ± 1.3b	16.2 ± 1.4	20.4 ± 1.8b	27.9 ± 2.1	40.1 ± 2.8b	71.2 ± 4.4	86.3 ± 3.4a	97.9 ± 3.3
R1 + RY4	15.8 ± 1.1ab	19.3 ± 1.2	23.0 ± 1.3ab	30.9 ± 1.3	43.6 ± 1.1ab	74.4 ± 3.0	89.8 ± 2.6a	102.0 ± 2.6
R2 + RY4	15.2 ± 1.6ab	18.1 ± 2.8	23.1 ± 2.8ab	29.4 ± 2.9	42.2 ± 3.0ab	72.0 ± 2.8	81.9 ± 2.6a	93.6 ± 3.0
R3 + RY4	17.7 ± 0.9ab	21.7 ± 1.3	26.2 ± 0.7ab	32.8 ± 0.8	45.1 ± 1.3ab	70.9 ± 2.5	85.0 ± 1.6a	96.6 ± 1.5

R4 + RY4	16.3 ± 1.6ab	20.1 ± 1.4	26.2 ± 1.4ab	32.9 ± 1.5	50.9 ± 4.8a	79.1 ± 10.6	90.2 ± 11.2a	102.5 ± 11.4
R5 + RY4	17.2 ± 2.4ab	21.1 ± 2.1	25.6 ± 1.6ab	32.3 ± 1.6	49.4 ± 3.0ab	77.6 ± 3.9	89.0 ± 4.8a	100.2 ± 5.4
R6 + RY4	14.9 ± 0.8ab	19.7 ± 1.6	26.0 ± 1.7ab	32.6 ± 1.6	47.2 ± 3.8ab	73.4 ± 3.8	84.4 ± 3.9a	95.7 ± 4.2

Different superscript letters of data in the same row indicate significant differences between different treatments ($p < 0.05$).