

日糧中不同粗蛋白來源對肉牛生長性狀之影響⁽¹⁾

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摘 要

12 頭聖達與台灣黃牛級進二代公牛，逢機均分為四組，以四種等量粗蛋白質及總可消化營養分，但不同蛋白質解離度之日糧，個別飼養 95 日，以探討不同解離度蛋白質對肉牛生長性狀之影響。試驗日糧依其所含粗蛋白質解離度不同而分為含 (A) 尿素 (B) 大豆粕 (C) 全脂熟黃豆粕 (D) 全脂熟黃豆粕加尿素等四組。試驗期間除了調查肉牛之增重，並經由活體消化試驗測定四種日糧之表面消化率 (Apparent digestibility)。試驗結果顯示 A、B、C、D 四組肉牛之每日平均採食量分別為 6.8 kg；7.2 kg；7.1 kg；7.4 kg 各組間並無統計上之差異 ($P>0.05$)。而其每日增重及飼料利用率分別為 1.25 kg，5.6；1.26 kg，5.5；1.23 kg，5.8；1.53 kg，5.0。其中以全脂熟黃豆粕與尿素組 (D 組) 之平均日增重及飼料利用率顯著優於其他三組 ($P<0.05$)。此外活體消化率測定上四組日糧之有機物質、中酸洗纖維及全氮之表面消化率，分別為 65.8%，67.9%，63.7%，76.6%；48.5%，49.3%，48.5%，61.7%；47.0%，48.9%，44.9%，58.6%；54.1%，55.8%，54.2%，65.6%。其間有組間之差異存在 ($P<0.05$)。本試驗結果顯示全脂熟黃豆粕加尿素組，因其粗蛋白來源能更經濟有效被利用，其營養成份之表面消化率也比其他三組為高，增重及飼料利用效率也比其他三組為佳。

關鍵詞：尿素、迴避蛋白、大豆粕、全脂熟黃豆粕、日增重、飼料利用效率、表面消化率、牛。

緒 言

反芻動物本身在維持、生長、泌乳及懷孕中均需要大量的氨基酸 (Chalupa, 1984; Little, *et al*, 1963)。一般而言，流至反芻動物小腸的氨基酸來自兩個方面，其一為日糧中蛋白質或胜肽，在逃避瘤胃微生物解離後流至皺胃，在皺胃中被分解成氨基酸而至小腸。其二則為日糧粗蛋白在瘤胃中先經瘤胃微生物分解成氨後，再由微生物合成微生物蛋白，最後這些微生物蛋白質在皺胃中被分解成氨基酸後再流至小腸 (Chalupa, 1975; Chalupa, 1984; Waldo and Glenn, 1984)。而胺基酸流至小腸之質與量越佳，其反芻動物之產能越佳。因此 NRC 建議在高產之反芻動物日糧裏添加低解離度之蛋白質以增加氨基酸流至小腸之質與量，然而此一過程又以不影響微生物蛋白之合成為要件 (NRC, 1985)。微生物蛋白所含氨基酸質與量均較一般日糧所含氨基酸為差 (Bergen, *et al*, 1968; Hudson, *et al*, 1970)。並且瘤胃微生物利用氨合成微生物蛋白時同時需足夠可資利用之熱能，方能順利進行。如果瘤胃中之碳水化合物所發酵產生之能量不足，則過多

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的氮將擴散出瘤胃壁而形成浪費，如果瘤胃中之氮濃度不足，則微生物將會死亡。因此瘤胃中適當熱能與氮濃度之平衡，對瘤胃微生物蛋白之合成有極其密切的關係存在 (Chalmers, *et al*, 1954; Satter and Slyter, 1974)。雖然反芻動物所需之氨基酸來源有前述兩種來源，惟大部份以微生物蛋白之供應為主 (Ferguson, 1975)。這對高產乳牛或快速增重之肉牛而言，僅靠微生物蛋白所供給之氨基酸量，無論在質與量上均無法滿足其需要 (Glimp, *et al*, 1967)。在此情形下，若能增加日糧中在瘤胃內不被解離之蛋白質之量，即所謂之迴避蛋白 (escape protein)，則不僅可避免日糧中高品質蛋白質被破壞及再合成所造成之能量浪費，同時也可迅速有效地經由皺胃之分解，提供肉牛所需之大量之氨基酸。在台灣，被使用最多最普遍的植物性蛋白質是大豆粕，它含有豐富之蛋白質及氨基酸，惟因所含之蛋白質解離度較高，以致在瘤胃裏常快速被瘤胃微生物所攻擊、分解，而快速解離，無法具有迴避蛋白之效應存在 (Ahrar and Schingoethe, 1979; Ashes, 1984; Tagari, *et al*, 1962)。

熱處理後之黃豆粕曾經被用來飼養肉羊之飼驗 (Su and Yun, 1990) 也曾經用持續性人工瘤胃來評估其瘤胃微生物之氨基酸的質與量 (Crawford, *et al*, 1980; Hoover, *et al*, 1976a; Hoover, *et al*, 1976b; Su and Yun, 1990; Weller and Pilgerim, 1974)，試驗顯示受處理後黃豆粕組有較少之氨基酸是由微生物合成的。雖然該方法可增加全脂熟黃豆粕之迴避蛋白在皺胃中之濃度 (Sahlu, *et al*, 1984)。然而，由於熱處理可能降低瘤胃氮濃度至危及微生物生長之必需量，因此非蛋白氮如尿素的添加利用，應能提供瘤胃中適當之氮濃度，以彌補前述熱處理全脂熟黃豆粕所造成的缺點。

本試驗之目的是探討肉牛對等量粗蛋白日糧的利用情形，並期盼能有效利用尿素之快速解離特性，以配合熱處理後大豆粕之低解離特性，一方面能生產更多的瘤胃微生物蛋白，另一方面藉迴避蛋白之形成，增加更多皺胃可利用之蛋白質，使快速生長階段之肉牛能獲得最經濟之增重。

材料與方法

I、試驗材料

II、試驗方法：本試驗為活體試驗 (In vivo)

- (i) 日糧先以 AOAC 方法 (AOAC 1975; Goering and Van Soest, 1970; Van Soest and Robertson, 1980) 分析其營養組成 (表 2)。
- (ii) 12 頭公牛，以逢機方法均分為四組，每組三頭，分別置於個別飼養欄中飼養。
- (iii) 試驗開始前，肉牛先予以驅除內寄生蟲，並予以一個月之適應期後，每頭給予前述日糧約 7.5 公斤，並記錄其每日個別採食量及剩餘量。
- (iv) 飼養試驗進行三個月，每月上旬稱重一次，並計算日增重、飼料採食量及飼料利用率。
- (v) 飼養試驗結束後，即進行活體試驗，以全糞收集法進行糞便收集，每日取 5% 之糞便冷藏，收集四天後再混合均勻，烘乾，進行組成分析 (AOAC 1975; Goering and Van Soest, 1970; Van Soest and Robertson, 1980)。
- (vi) 本試驗採用簡單逢機分析 (Duncan, 1955; SAS, 1979)。

表 1. 試驗日糧組成表

Table 1. Composition of experimental diets.

	A	B	C	D
	%			
Pangola hay	12.75	12.75	12.75	12.75
Corn	84.00	72.50	68.50	73.50
Soybean meal	—	13.00	—	—
Heat-treated soybean meal	—	—	17.00	11.50
Urea	1.50	—	—	0.50
Dicalcium phosnhate	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Calcium sulfate	0.25	0.25	0.25	0.25
Vitamin premix	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00

A：尿素組 (Urea)

B：大豆粕組 (Soybean meal)

C：全脂熟黃豆粕 (Heat-treated soybean meal)

D：全脂熟黃豆粕加尿素組 (Heat-treated soybean meal plus urea)

* 全脂熟黃豆粕是將全脂黃豆置於密封容器內，以580°F之熱風乾燥後，再加以磨成粉狀

* Heat-treated Soybean meal was made by setting whole Soybean into closed chamber and dry by 580°F wind, and then ground then into power.

表 2. 日糧化學組成表

Table 2. Chemical analysis of experimental diets.*

	A	B	C	D
	%			
Dry matter	88.3	88.7	89.0	88.9
Crude Protein	11.2	13.8	12.0	12.4
NDF	23.4	23.2	23.6	23.3
ADF	10.2	10.9	10.3	10.2
ASH	3.2	5.3	4.0	4.0

A：尿素組 (Urea)

B：大豆粕組 (Soybean meal)

C：全脂熟黃豆粕 (Heat-treated soybean meal)

D：全脂熟黃豆粕加尿素組 (Heat-treated soybean meal plus urea)

* TDN 係為估算值，上述日糧之TDN 約為 0.72 公斤/公斤乾基。

* TDN was an estimated value. Rations contain 0.72kg TDN per kg ration on dry matter basis.

結果與討論

試驗結果顯示，A、B、C、D 四組肉牛在試驗階段之平均每日採食量雖略有差異，依序分別為 6.8 kg, 7.2 kg, 7.1 kg 及 7.4 kg。然各組間無顯著差異 ($P>0.05$)，顯示肉牛在試驗階段營養之攝食相當一致。然含尿素日糧之採食較其他三組為低，這是尿素降低其適口性所致 (NRC, 1985; Su and Yun, 1990)。各組肉牛平均每日增重及飼料利用效率分別為 1.25 kg, 5.6; 1.26 kg, 5.5; 1.23 kg, 5.8 及 1.53 kg, 5.0。採食全脂熟黃豆粕加尿素日糧之肉牛平均每日增重及飼料利用率較其他三組為佳，並有顯著差異 ($P<0.05$)，此與 Su and Yun (1990)，Waldo and Glenn (1984) 及 Wohlt and Clark (1978) 等人分別使用熱處理蛋白或尿素餵飼肉羊及乳牛所得之效應相類似。可能為大豆經過加熱處理後，其蛋白質解離度很顯著降低，使其本身蛋白質被瘤胃微生物攻擊，而分解也降低，以致有更多蛋白質能快速地為皺胃所利用 (Tagari, *et al*, 1962)。加以尿素提供其不足之氮濃度使瘤胃微生物能合成更多之微生物蛋白 (Satter and Roffler, 1975; Su and Yun, 1990)。惟完全使用全脂熟黃豆粕日糧之肉牛，雖增加迴避蛋白之量，相對的，卻減少了瘤胃微生物賴以生長及繁殖所需要之適當氮濃度，所以增重及換肉率均不如其他三組 (表 3)，因此在熱處理大豆粕之日糧裏添加尿素，由於此日糧之尿素具有快速解離成氮之特性，故能滿足瘤胃微生物之需要，並且其進入小腸之氨基酸較多 (Waldo and Glenn, 1984)，而獲得較佳之增重及飼料利用效率 (Little, *et al*, 1963; Satter and Roffler, 1975; Wohlt and Clark, 1978)。

再者，由表四活體消化試驗之數據顯示，肉牛對於每日有機物質，全氮量，中洗纖維及酸洗纖維之採食量，不因日糧中含有不同來源之粗蛋白質，而有顯著差異 ($P>0.05$)。然 D 組之有機物質採食量比其他三組略佳，這可能是該日糧之風味較佳所致，而 A 組之有機物質採食量也較其他三組低，這是因為日糧中含有 1.5% 之尿素，而降低了適口性 (Su and Yun, 1990)，而在糞便排出成份上，有機物質，全氮量，中洗纖維及酸洗纖維之排出量以 D 組最少 ($P<0.05$)，而其他三組間則無顯著差異 ($P>0.05$)。這可能是熱處理後降低了蛋白質之解離度，使得該日糧之營養成份滯留在消化腸道之時間增長所致 (Stern, 1984; Veen, 1986)，對表面消化率而言 (表 4)，D 組之有機物質之表面消化率較其他三組為高 ($P<0.05$)，Oldham *et al* 報告指出用低解離度之魚粉—大麥日糧來餵飼女牛時增加了有機物質之表面消化率 (Oldham, *et al*, 1985)，此外，Lindberg 報告指出魚粉—大麥日糧之餵飼羊隻不僅提高有機物質之表面消化率也進而提高了中洗纖維之表面消化率 (Lindberg, 1984)，因此從表四中也證實肉牛採食 D 組日糧也有較高之中洗纖維表面消化率 ($P<0.05$)。在酸洗纖維之表面消化率比較上，也可以得到肉牛採食 D 組日糧有較其他三組日糧為佳之酸洗纖維表面消化率 (表 4) ($P<0.05$)，這與日糧中以低解離度蛋白取代高解離度蛋白後會提高其中洗及酸洗之表面消化率之成果相當一致 (McAllan and Griffith, 1987)。Veen 發現降低蛋白質解離度，造成氮、氮等元素被慢速釋離，由於營養元素之滯留瘤胃，而使得嗜纖維細菌有較長時間來利用 (Veen, 1986)。再由表四得知糞便中之氮含量以 D 組最低 ($P<0.05$)，這顯示 D 組氮滯留時間增長，以及採食 D 組肉牛之小腸氨基酸量增加 (Ahrar and Schingoethe, 1979; Glimp, *et al*, 1967; Su and Yun, 1990; Wohlt and Clark, 1978) 故其糞便中之氮為最少，因而在氮之表面消化率上比其他三組高 (表 4)，故總體而言，迴避蛋白與尿素之相互應用，提高了動物之有機物質，氮，中洗纖維及酸洗纖維之表面消化率，因而使採食該組日糧之肉牛的平均每日增重及飼料換肉率均較其他三組好。

綜合上述資料顯示，熱處理之全脂熟黃豆粕加尿素之日糧，由於增加迴避蛋白及微生物蛋白之量，因而更能有效被肉牛利用，促進及提高飼利用效率。

表 3. 不同蛋白質來源對肉牛生長性能之影響

Table 3. Effect of dietary nitrogen sources on growth performance of beef cattle.

	A	B	C	D	SE
Number of animals	3	3	3	3	
Initial weight(kg)	281.7±17.0	295.0±10.8	306.7±20.1	311.7±6.2	
Final weight (kg)	403.3±28.7	415.0±28.6	430.0±14.1	453.3±36.8	
Average daily gain weight per head (kg)	1.25 ^a	1.26 ^a	1.23 ^a	1.53 ^b	0.1
Feed intake per head (kg)	6.8 ^a	7.2 ^a	7.1 ^a	7.4 ^a	0.7
Feed efficiency	5.6 ^a	5.5 ^a	5.8 ^a	5.0 ^b	0.2

A：尿素組 (Urea)

B：大豆粕組 (Soybean meal)

C：全脂熟黃豆粕 (Heat-treated soybean meal)

D：全脂熟黃豆粕加尿素組 (Heat-treated soybean meal plus urea)

* 同一橫行中英文字母相同者表示在統計上無顯著差異 ($P>0.05$)

The same superscripts (a) in the same raw indicate statistically nonsignificant difference ($P>0.05$).

日糧中不同粗蛋白來源對肉牛生長性狀之影響

表 4. 活體消化試驗之有機物質、全氮、中洗纖維、酸洗纖維之每日採食量及其表面消化率
 Table 4. Intake volumes and apparent digestibilities of organic matter, nitrogen, neutral detergent fiber and acid detergent fiber in the digestive tract of beef cattle fed four rations.

	A	B	C	D	SE
	g/d				
Intake (daily)					
Organic matter	5812a	6048a	6066a	6315a	262
Neutral detergent fiber	1405a	1482a	1479a	1533a	96
Acid detergent fiber	612a	696a	651a	671a	74
Nitrogen	309a	405a	349a	375a	84
Feces (daily)					
Organic matter	1988a	1941a	2202a	1478b	256
Neutral detergent fiber	724a	751a	771a	587b	54
Acid detergent fiber	324a	356a	359a	278b	43
Nitrogen	142a	179a	160a	129b	20
Apparant digestibility** (% of intake)	%				
Organic matter	65.8a	67.9a	63.7a	76.6b	5.1
Neutral detergent fiber	48.5a	49.3a	48.5a	61.7b	8.3
Acid detergent fiber	47.0a	48.9a	44.9a	58.6b	5.7
Nitrogen	54.1a	55.8a	54.2a	65.6b	6.4

A: 尿素組 (Urea)

B: 大豆粕組 (Soybean meal)

C: 全脂熟黃豆粕 (Heat-treated soybean meal)

D: 全脂熟黃豆粕加尿素組 (Heat-treated soybean meal plus urea)

* 同一橫行中英文字母相同者表示在統計上無顯著差異 ($P>0.05$)The same superscripts (a) in the same row indicate statistically nonsignificant difference ($P>0.05$).

** 表面消化率 = (攝食量 - 排糞量) / 攝食量

Apparant digestibility = (Intake volume - Feces volume) / Intake volume.

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Effect of Different Protein Sources on the Performance Test of Beef Cattle⁽¹⁾

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Abstracts

Twelve Santa Gertrudis and Taiwan Yellow up-graded yearling bulls, were divided into four groups randomly. They were fed four rations which contained same levels of crude protein and total digestible nutrient but different ability of degradation of crude protein. Rations, named by different degradation of crude protein, were (A) UREA, (B) SOYBEAN MEAL, (C) HEAT-TREATED SOYBEAN MEAL and (D) HEAT-TREATED SOYBEAN MEAL PLUS UREA. Results showed that the average daily dry matter intake of four treatments were 6.8 kg; 7.2 kg; 7.1 kg and 7.4 kg respectively, but there were no significant difference among them ($P > 0.05$); The average daily gain and feed efficiency were 1.25 kg, 5.6; 1.26 kg, 5.5; 1.23 kg, 5.8; 1.53 kg, 5.0. respectively. The average daily gain and feed efficiency of D ration were significant difference among another three rations ($P < 0.05$). The apparent digestibility of organic matter, neutral detergent fiber, acid detergent fiber and total nitrogen of cattle were 65.8%, 67.9%, 67.9%, 76.6%; 48.5%, 49.3%, 48.5%, 61.7%; 47.0%, 48.9%, 44.9%, 58.6% and 54.1%, 55.8%, 54.2%, 65.6% respectively. There were significant difference among them ($P < 0.05$). Therefore, from the result of this experiment, it was found that the ration of heat-treated soybean meal plus urea can be used for improving the daily gain weight and feed efficiency economically.

Key words : Urea, Escaped protein, Soybean meal, Heat-treated soybean, Daily gain weight, Feed efficiency, Apparent digestibility, Cattle.

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