

Protein quality and metabolic effects of single cell proteins evaluated in rats



Calvez J¹, Blais A¹, Andriamihaja M¹, Chapelais M¹, Gaudichon C¹, Marie B², Cameleyre X², Guillouet S², Dubreuil B³, Pontalier PY³, Raynaud C^{3,4}, Gorret N²

LABORATOIRE DE CHINAGRO-INDUSTRIELLE

C A T A

¹ PNCA, INRAE, AgroParisTech, Université Paris-Saclay, Paris, France; ² TBI, Université de Toulouse, CNRS, INRAE, INSA, Toulouse, France; ³ Laboratoire de Chimie Agro-industrielle, Université de Toulouse, INRAE, INPT, Toulouse, France; ⁴ Centre d'Application et de Traitement des Agro-Ressources (CATAR), Toulouse-INP, Toulouse, France



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BACKGROUND

Single Cell Proteins (SCP)



Wistar male rats

21 days

Reverse light/dark cycle 1 rat/cage

Control (casein, n = 8)

Y1 (n = 8)

B1 (n = 8)

New source of proteins, alternative to animal sources

High content in nucleic acids (risk of hyperuricemia)

Study 1: Protein quality of Y1 and B1

Protein efficiency ratio (PER) = -

* FAO 2013 reference pattern for older child, adolescent, adult

Fecal N digestibility* (%) =

 * Use of 15 N-casein, Y1 and B1 to track dietary N

Limited uses in human food



Protein intake (28 d)

Body weight gain (28 d)

N ingested – N fecal losses

mg AA in 1 g of reference protein* x fecal N dig.

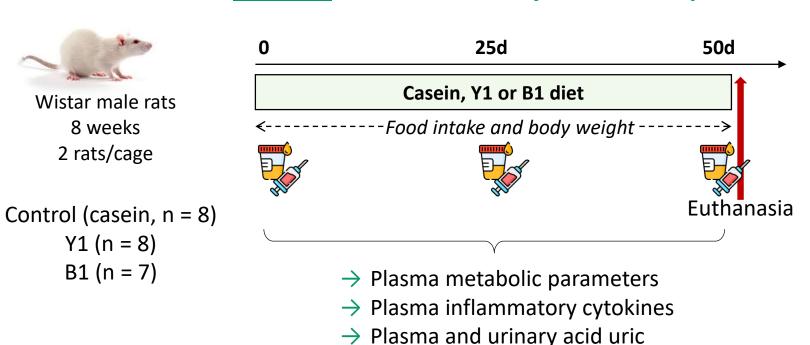
Production of SCP from yeast (Y1) and bacteria (B1) with decreased nucleic acid content

OBJECTIVES

- → To evaluate the protein quality of Y1 and B1 in rats
- → To determine the effect on 50 days of Y1 and B1 intake on health-related parameters in rats

METHODS

Study 2: Effects of 50 days of consumption of Y1 or B1



	CASEIN	Y1	B1
	CASEIN	11	PI
Ingredients in g/kg			
Casein, Y1 or B1	105	195	135
Starch	658	568	628
Sucrose	100	100	100
Soy oil	40	40	40
Mineral mix	35	35	35
Vitamin mix	10	10	10
Cellulose	50	50	50
Choline	2,3	2,3	2,3
Nutritional composition			
Protein (%P/E)	14	14	14
Carbohydrate (%C/E)	75	75	74
Lipid (%L/E)	10	10	11
Energy (kcal/kg)	3750	3737	3751

RESULTS

Study 1: Protein quality of Y1 and B1

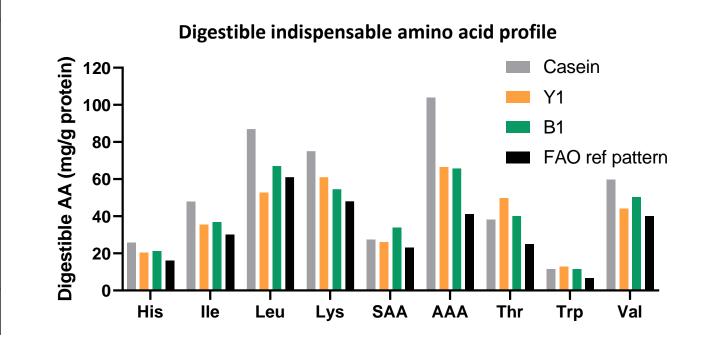
mg limited AA in 1 g of test protein

Amino acid composition of casein, Y1 and B1

	CASEIN	Y1	B1	pattern
Dispensab	le amino a	acids		•
Ala	28	73	87	
Arg	37	45	80	
Asx	61	103	91	
Cys	3	14	10	
Glx	193	105	124	
Gly	16	53	58	
Pro	106	80	44	
Ser	52	59	39	
Tyr	58	38	34	
Indispensa	able amino	acids (m	g/g prot)	
His	28	27	27	16
Iso	51	46	46	30
Leu	93	69	84	61
Lys	80	80	68	48
Met	26	20	32	
AAS	29	34	42	23
Phe	53	49	48	
AAA	111	87	82	41
Thr	41	65	50	25
Trp	12	17	14	7
Val	64	57	63	40
Protein (g/100 g)	93	37	59	

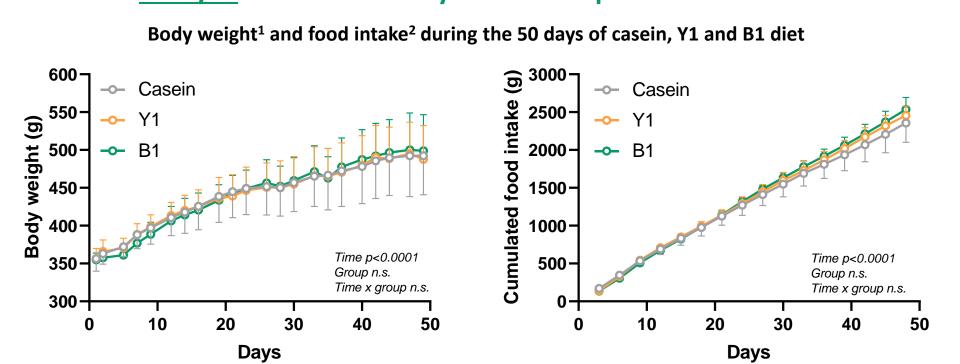
Protein quality parameters casein, Y1 and B1

Protein sources	CASEIN	Y1	B1	ANOVA p-value ²
PER ¹	2.5 ± 0.1 ^a	1.7 ± 0.1 ^b	2.3 ± 0.1 ^c	<0.0001
Fecal N digestibility (%)	93.7 ± 1.1 ^a	76.6 ± 5.1 ^b	79.7 ± 4.8 ^b	<0.0001
PDCAAS (untruncated)	1.2	0.9	1.1	-



- → PER and fecal N digestibility of Y1 and B1 were significantly lower than casein
- → Thanks to a balanced amino acid composition, PDCAAS of Y1 is good and that of B1 is excellent

Study 2: Effects of 50 days of consumption of Y1 or B1



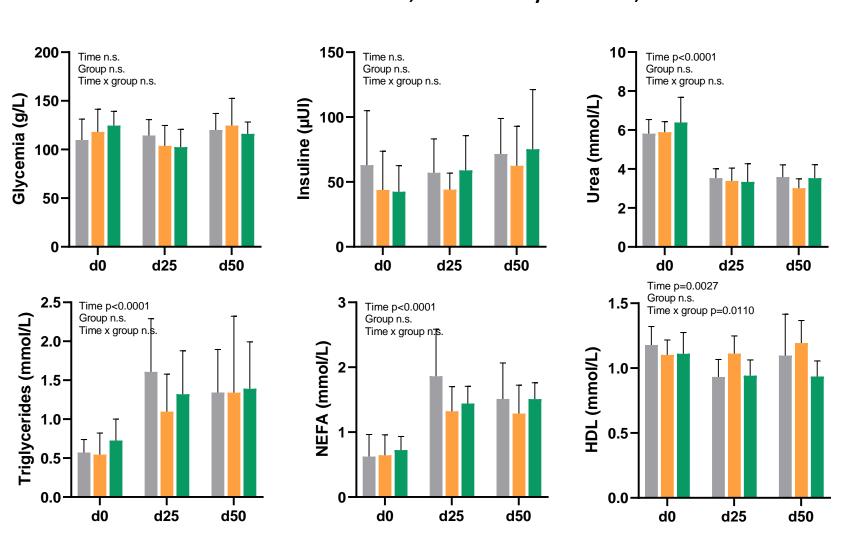
¹ Two-way Anova (group, time); ¹ Two-way Anova (group, time) on n = 4 (2 rats/cage; 7-8 rats/group)

Body composition after 50 days of casein, Y1 and B1 diet

	CASEIN	Y1	B1	ANOVA p-value ²
Final body weight (g)	497 ± 49	492 ± 42	507 ± 52	ns
Fat mass (g)	71 ± 21	61 ± 13	78 ± 29	ns
Lean mass (g)	426 ± 31	430 ± 31	428 ± 29	ns
Naso-anal length (cm)	25 ± 1	26 ± 1	26 ± 1	ns
Femoral BMD (g/cm²)	0.24 ± 0.01	0.25 ± 0.01	0.24 ± 0.01	ns
Spleen (g)	0.9 ± 0.1	0.9 ± 0.3	1.0 ± 0.1	ns
Pancreas (g)	1.4 ± 0.3	1.5 ± 0.2	1.7 ± 0.2	ns
Liver (g)	15 ± 2	13 ± 2	14 ± 2	ns
Kidneys (g)	2.4 ± 0.2	2.6 ± 0.3	2.6 ± 0.3	ns
Stomach (g)	1.8 ± 0.2	2.0 ± 0.2	2.0 ± 0.2	ns
Small intestine (g)	7.5 ± 2.9	8.4 ± 1.1	10.0 ± 1.6	ns
Caecum (g)	1.0 ± 0.1^{a}	1.5 ± 0.2 ^b	1.3 ± 0.1 ^c	<0.0001
Colon (g)	1.9 ± 0.2	1.9 ± 0.3	1.9 ± 0.2	ns

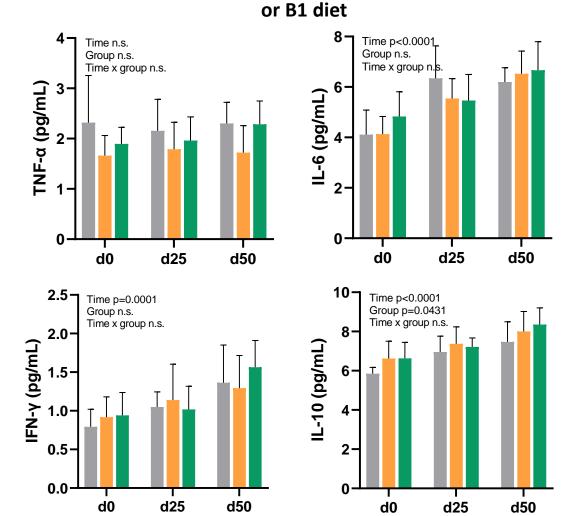
→ 50 days of Y1 or B1 diet did not alter food intake, body weight gain or body composition

Plasma metabolic markers after 0, 25 and 50 days of casein, Y1 or B1 diet



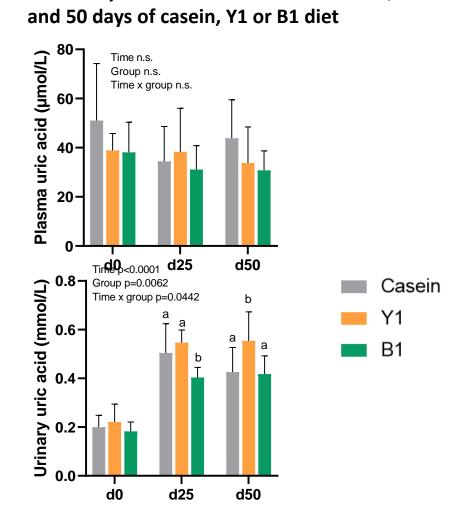
→ Fasting plasma metabolic parameters did not differ between consumption of Y1 or B1 diet versus a casein diet

Plasma inflammatory cytokines after 0, 25 and 50 days of casein, Y1



→ Plasma inflammatory cytokines levels did not differ between consumption of Y1 or B1 diet *versus* a casein diet

Plasma and urinary uric acid concentration after 0, 25



→ An increase in urinary uric acid was observed after 50 days of Y1 diet, while no difference in plasma acid uric concentration was found, suggesting an efficient excretion of uric acid

CONCLUSION

- Despite a moderate PER, the **protein quality of Y1 and B1 was very good** (PDCAAS of 0.9 and >1, respectively), with the moderate fecal protein digestibility offset by a balanced amino acid profile. During the 50 days of consumption of Y1 diet, the uric acid produced during the catabolism of nucleic acids present in yeast appeared to be well excreted by the body. Hence, in our experimental conditions, **no effect on metabolic and inflammatory markers** has been observed after mid-term consumption of Y1 and B1.
- In conclusion, reducing the nucleic acid content of SCP has enabled to obtain protein with no apparent deleterious health effects after mid-term consumption in rats, yet with good protein quality. While organoleptic and regulatory issues remain to be solved, SCP are an interesting option for expanding the range of new sources of good-quality protein for human.