Nutritive Value of Coconut, Cashew and Canary Nuts

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by

Oey Kam Nio*, Lie Goan Hong*, J. Herlinda*, G. Nainggolan-Sihombing*, Risnawati Aminah* and Sumardi**.

* Nutrition Unit Diponegoro, National Institute for Health Research and Development, Ministry of Health, Jakarta.

** National Institute for Chemistry, Indonesian Institute of Sciences, Bandung.

Coconut, cashew and canary nuts are seeds very rich in oil. Of these three nuts, only the coconut is commercially cultivated in large estates for its oil. It is by far the most important source of cooking oil for the population in Indonesia. Of the other two nuts, the cashewnut fried, is internationally highly appreciated as an expensive delicacy ; while the canary nut is probably only known in South East Asia as an ingredient in some luxury cakes. According to Heijne, 1950, in the Eastern part of Indonesia (Moluccas) where much canary nuts are harvested, these nuts are so commonly used in the various native sago recipe's.

The coconut protein, as reported in our previous paper (Oey, K.N. et al. 1977), is of good quality, but the amino acid content of the coconut samples used, was not reported. Recently, at the National Institute for Chemistry in Bandung, the chemical analysis of amino acids has become an established routine procedure. A new set of investigation of coconut was therefore carried out again. Cashew and canary nuts were also included, as no data on their chemical composition and the protein nutritive value were found in the Indonesian literature.

- Paper presented at the Third Symposium of the Federation of Asian and Oceanian Biochemists, held in Denpasar (Bali), Indonesia, June 24-27, 1981.
- This investigation was carried out in cooperation with the ASEAN Project on Soybean and Proteinrich Foods Indonesia.

Materials.

Coconut gratings were prepared in our Nutrition Unit from mature coconuts bought from a market in Central Jakarta. The coconut meat was grated and then dried in the oven at a low temperature of 60° C for about one day avoiding discolouring (browning) of the product. To reduce its high fat content and at the same time increasing the protein content, the dried coconut gratings were pressed between thick layers of paper using a simple localmade screwpress.

Desiccated coconut and coconut flakes were obtained from a factory in the northern part of Celebes. Coconut flake is a byproduct of the production of desiccated coconut. Desiccated coconut which did not meet the standards as set for export, was pressed for its edible oil. The residue obtained was as thin flakes, light yellowbrown in colour, having a very acceptable slightly toasted taste and flavour. No rancidity was observed. These flakes were sold locally for feed.

Peeled cashew and canary nuts bought also from a market in Central Jakarta, were dried in the oven at 60° C for about one day. To reduce the high fat content, the nuts were ground and pressed in the same way as the coconut gratings.

The very high content of fat of these three nuts has to be reduced to make them suitable for preparing the experimental diets with 10 % protein and 10 % fat.

Methods.

a. Chemical analysis.

The determination of the proximate principles and the crude fibre content was carried out according to AOAC methods (1977).

The amino acid analysis was carried out at the National Institute for Chemistry in Bandung, using the automated ion-exchange chromatographical method as described by Anderson and Jackson (1977).

b. Ratfeeding trials.

All the rat feeding experiments were carried out using young weanling albino rats of the same inbred strain ("Lembaga Makanan Rakyat"-strain), bred in our Nutrition Unit.

The determination of PER- and NPU-values was carried out according to standard methods as recommended by AOAC (1965) for PER and according to Miller (1963) and Miller & Bender (1955) for NPU.

Table: 1

Proximate principles of various Coconut products,
Cashew and Canarium nut
(original material as received)

No. FOOD ITEM	Moisture %	Protein (Nx5.30) %	Fat %	Carbohydrate by diff. %	Ash %	Crude fiber %
1. Coconut (Cocos nucifera)						
a. Coconut grating, (freshly prepared)	46.9	3.4	34.7	14.0	1.0	2.5
b. Desiccated Coconut (ex factory in North Sulawesi) (Coarse and macaroon TIPA)	1.8	5.9 (6.3)	64.4	23.3	1.7	4.4
c. Coconut flakes (ex factory in North Sulawesi) TIPA	3.8	17.4	11.0	60.4	5.42	9.9
2. Cashew nut (Anacardium Occidentale) peeled, raw, from market (after additional drying in oven)	5.1	14.9	50.7	27.1	2.23	3.4
3. Canarium nut (Canarium Commune) peeled, raw, from market (after additional drying in oven)	4.6	13.0	69.1	9.8	3.5	3.5

Results.

a. Chemical Composition.

The values obtained for the proximate principles are presented in Table 1. The result of the amino acid analysis is given in the Addendum Table 1. Only the value for methionine is presented, as the value for cystine due to technical reasons is not determined.

b. Biological Experiment.

The values for Protein Efficiency Ratio are given in Addendum Table 2 and for Net Protein Utilization in Addendum Table 3. In the Addendum Tables 4, 5, 6 and 7 information pertaining to the preparation of the experimental diets and detailed information on the PER study are presented.

Discussion.

a. Chemical Composition.

The proximate principles of the three nuts can be seen from Table 1 (see Table 1). On dry basis, Canary nut has the highest fat content with close to 70 %, followed by desiccated coconut with close to 65% and cashew nut with approximately 50 % fat only.

Cashewnut and canary nut have a protein content in the range of 13 to 15 %, while desiccated coconut has a lower protein content of about 6 % only. When the fat is pressed out from desiccated coconut the protein content increases to about 17 %, which can be seen from the composition of coconut flakes in Table 1. (See Table 1). This value of 17 % is slightly higher than the proteinvalue of Cashewnut (15 %) and Canary nut (13 %).

b. Amino acid analysis.

As can be seen from Table 2 and more detailed in Addendum Table 1, the lysine and most probably the total Sulfur-containing amino - acids are the most limiting amino acids in the protein of the three aforementioned nuts. Although no clearcut data on the total Sulfur-containing amino acids are available, but based on the results of the ratsexperiments, one may speculate that the magnitude of these deficiencies are probably not severe.

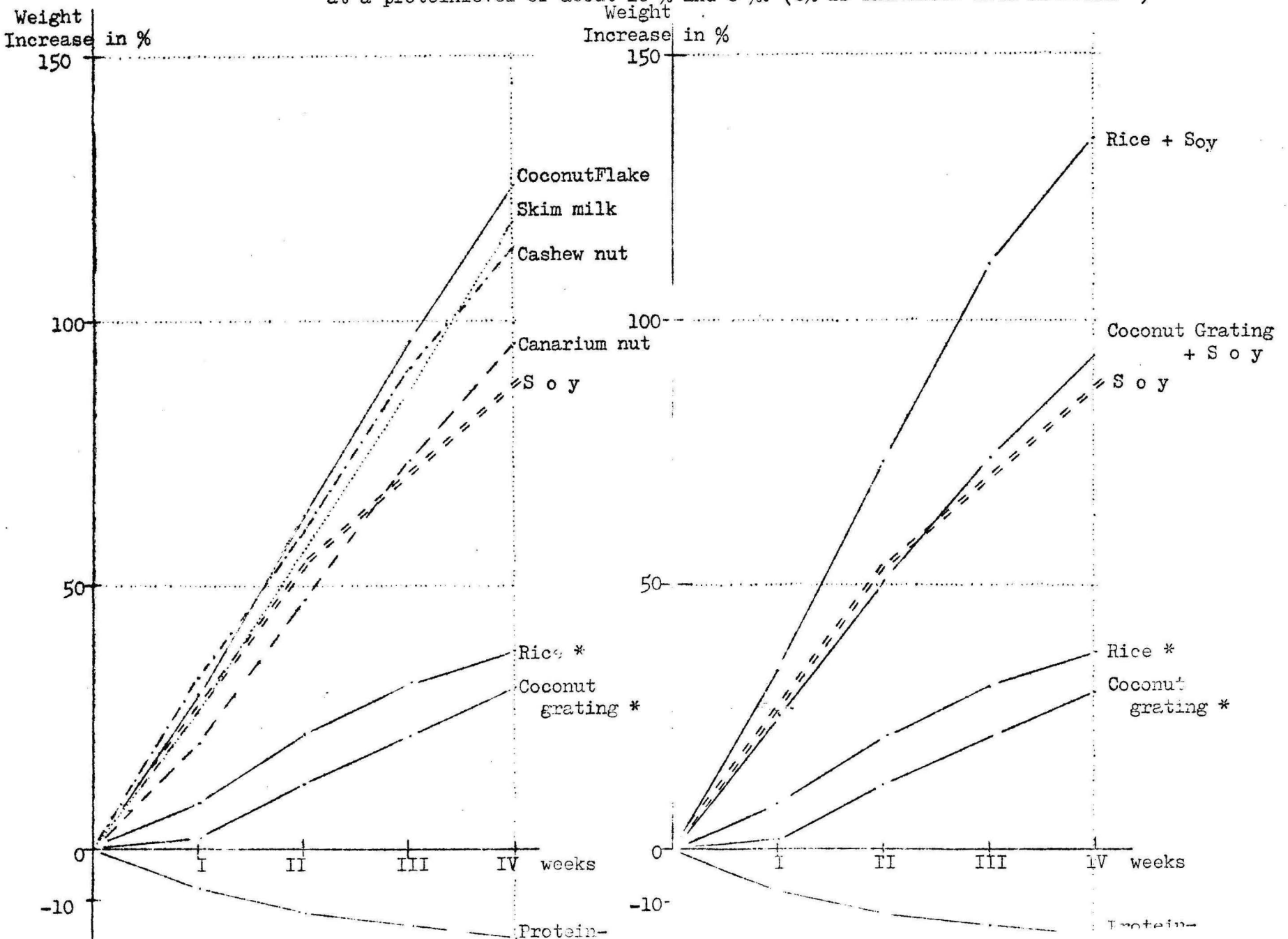
Table : 2 Summary of Results obtained and Comparison with 3 selected Legumes.

commodity :	Moisture %	Nitrogen %	Conversion faktor	Protein %	Calculated Amino acid Score: Lysine (100%= ~~300~~ 340 mg/gN)	Calculated Amino acid Score: Total S-c aa. 100%= 220mg/gN	Obtained: PER	Obtained: NPU	Obtained: BV
Coconut :									
Coconut grating dried	12.2	1.25	5.30	6.6	65	89	2.4	.	.
Desicc. Coconut TINA	4.8	1.11	5.30	5.9	96	-	.	71	83
Flour, defatted	3.8	2.68	.	14.2	75	82	.	.	.
Coconut Flakes TINA	5.8	3.28	5.30	17.4	93	-	3.0	73	89
Cashew nut	4.0	3.47	.	18.4	90	57	.	.	.
	5.1	2.81	5.30	14.9	82	-	3.3	77	84
Canarium nut	4.6	2.45	5.30	13.0	71	-	2.5	63	69
S o y a)	10.3	5.74	5.71	32.8	115	75	2.5 (2.5-2.8)	59 (59-65)	70 (70-76)
P e a n u t a)	8.4	4.51	5.46	24.3	62	53	1.9	47	53
Kidneybean a)	9.2	3.54	6.25	22.1	147	46	1.7	46	55
R i c e	.	1.18	5.95	7.0	73	111	2.0	.	.
Rice + Soy Mix N-ratio = 50 : 50	.	1.66	5.83	9.7	94	93	3.1	.	.
Coconut grating + Soy Mixt. N-ratio = 50 : 50	.	1.79	5.43	9.7	90	82	3.0	.	.

Source : - a) K.N. Oey et al. 1980. Nutritive Value of Five Indonesian Legumes.
- Other data from ADDENDUM Tables 1,2 & 3.

Graph.

Growthcurves of young weanling albinorats fed various diets consisting of single or mixed proteins at a proteinlevel of about 10 % and 6 %. (6% is indicated with asterisk *)



c. Animal Experimentation.

The growthcurves of the young rats fed the various experimental diets in the Protein Efficiency Ratio study (PER) can be seen from the Graph. See Graph. The group with the best growthrates consists of Coconut flakes, Skim milk and Cashew nut. The group with a lower growthrate is composed of Canary nut and Soy. The growthrate of the rats fed on soy as the single source of protein is taken from another paper by the same authors presented in this same symposium by Oey K.N. et al.,1981. The lowest growthrate is from the group of Rice and Coconut grating. This low growthrate observed can be partly explained by the low foodintake of the rats. When soy was added to either the rice or coconut grating, the experimental diets were better consumed and a very good growth rate was then obtained as can be seen from the graph. "Rice+Soy" is the best and "Coconutgrating+Soy" is conspicuously less, but yet far much better than Rice or Coconut grating alone.

The values for PER and NPU are given in Table 2 and more detailed in Addendum Table 2. As can be seen from Table 2, Cashew nut has the highest value with a PER of 3.3 and a NPU of 77. Coconut flake comes next with a PER of 3.0 and a NPU of 73, values which confirm the earlier findings reported by Oey K.N. et al. 1977. Canary nut has the lowest values with a PER of about 2.5 and a NPU of 65. Skim milk protein as a positive control gives a PER of 3.2 and a NPU of 74, as can be seen from Addendum Tables 2 and 3.

Based on the growth rates and the PER and NPU values obtained, one may conclude that the quality of the protein of cashew nut and coco nut flakes are in the same group as skim milk. This may be an indication that the deficiency of total Sulfur-containing amino acids is not severe, and the scores for these total Sulfur-containing amino acids may be higher or at least equal to soy with 75 %.

The quality of Canary protein is lower than that of skim milk, cashewnut and coconut flakes, but still it is in the same group as soy protein. It has the same growthcurve, PER values in the range of 2.5 - 2.8 and NPU values between those of the soy protein. Although the quality is the same, but its protein content is only half of that of soy.

The fat content of the mature Canary nut is almost 70 %, which is 3 times as high as that of Soybean, and almost the same as that of dried mature coconut, such as copra and desiccated coconut. For this reason, according to Heijne 1950, the canary nut about half a century ago was used in the Moluccas by the local population as a source of cooking oil; but this oil becomes very soon rancid. In regions where the canary nut may be abundant and cheap, its use may be promoted to increase the nutritive and the energy value of the local sago diet.

Fresh coconut gratings, usually with a little salt added, are eaten mixed with rice-cakes, boiled or steamed cassave ("tiwul") and as a component of a vegetable dish ("urap") consisting of boiled legume-pods, mungbean sprouts etc. Because of its high biological value and good acceptability, increased use of fresh coconut meat may certainly be promoted, although admittedly in the cities the price of coconut may be prohibitive.

Copra presscake or "bungkil kopra", a by-product from the oilfactories, is obtained from grated copra after expelling its oil. It still contains the coconut protein and residual oil. It is sold and exported for animal feed. No authoritative information can be collected on the possible use of copra presscake or "bungkil copra" as human food for the preparation of "tempeh bongkrek", a wellknown and popular fermented food in Central Java (Lie 1981). Most prabably, copra presscake is never used for the manufacturing of "tempeh bongkrek", because of its darkbrown colour and contamination with dirt and other foreign matter, apart from the question whether it will give an acceptable fermented final product.
Being a village enterprise, it is highly conceivable, that "tempeh bongkrek" is always prepared from the abundant wasteproduct of the village oil industry, in which frash coconut meat is grated and after mixing with water is manually squeezed for its coconut milk or emulsion. These fresh residual coconutgratings, white in colour, if fermented, will give a greyish-white soft compact tempeh bongkrek.

Coconut flakes, a byproduct of the modern desiccated coconut factory, are apparently handled in a more hygienic way. Coconut flakes are therefore potentially acceptable for incorporation in human foods, being cheap and if demanded by the food industry, will perhaps become more available in greater quantity. Its high acceptability and high protein content combined with a good quality, pose a challenge to the foodtechnologist for finding ways and means for its greater use in the manufacturing of more and new foods for the public.

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ADDENDUM
Table : 1

AMINO ACID CONTENT OF COCONUT, CASHEW AND CANARY NUT EXPRESSED in mg/g of Total Nitrogen. Compared to the provisional amino acid pattern.

		Moisture %	Nitrogen %	Prot. Nx5.30 %	IsoLe	Le	Ly	Me	Cy	Tot. S-c. a.a.	Phe-Al	Ty	Tot. arom. a.a.	Thr	Try	Va	Lim. a.a.	Chem. Score
Provisional amino acid pattern (FAO/WHO 1973)		-	-	-	250	440	340	-	-	220	-	-	380	250	60	310	-	100
Coconut: (Cocos Nucifera)																		
a.Dried kernel	*	12.2	1.25	6.6	244	419	220	120	76	196	283	167	450	212	-	339	Ly	65
Desiccated Coconut TINA	***	4.8	1.11	5.9	265	455	325	145	-	-	284	170	454	245	-	282	?	.
b.Flour,defatted	**	3.8	2.68	14.2	259	405	254	156	25	181	221	82	303	188	-	313	Ly	75
c.CoconutFlakes TINA	***	5.8	3.28	17.4	230	390	316	115	-	-	258	132	390	190	-	288	?	.
Cashewnut: (Anacardium occidentale)	*	7.6	3.28	17.4	322	513	287	94	-	-	266	-	-	203	115	362	.	.
	**	4.0	3.47	18.4	250	400	306	56	69	125	256	125	381	250	100	369	S-c	57
	***	5.1	2.81	14.9	266	422	280	70	-	-	292	190	482	198	105	370	.	.
Canarynut:																		
- Canarium Schweinfurthii	*	6.0	4.08	21.6	238	438	181	194	-	-	244	188	432	200	-	344	Ly	53
- Canarium Commune	***	4.6	2.45	13.0	210	410	240	110	-	-	288	325	613	199	140	246	Ly	71

Source: * FAO - Nutritional Studies No.24. Amino Acid content of Foods and Biological Data on Protein.p.64&66.1972

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*** Dr. Sumardi, National Institute for Chemistry-Indonesian Institute of Sciences,(LIPI), Bandung.

ADDENDUM

Table : 2 Results of Protein Efficiency Ratio Determinations of Coconut gratings, Flakes and combinations, Cashew nut and Canarium nut.

EXPERIMENTAL DIET	Number of rats n	Protein content of XP. diet as anal. %	Avg. Body weight at start. g	Avg. Body weight at end g	Average increase in weight at end g	Average increase in weight at end %	Total Food Intake per rat (4 weeks) g	Total Protein Intake per rat (4 weeks) g	Protein Efficiency Ratio PER ± SD	Net Protein Ratio NPR	NPR x 16 (≙NPU)
A. Protein Free	10	0	50.3	33.1	-17.2	-34.2	64.8	0	-	-	-
B. Skim Milk	10	9.5 (Nx6.38)	50.1	110.4	60.3	120.5	196.9	18.71	3.22 ± 0.23	4.1	66
C. Coconut Gratings, dried, (pressed 1 x)	6	5.8 (Nx5.30)	49.8	61.8	12.1	25.3	110.3	6.39	2.37 ± 0.41	4.6	73
D. Coconut Flakes TINA	10	10.0 (Nx5.30)	49.8	112.5	62.7	126.2	207.8	22.96	3.02 ± 0.22	3.5	56
E. Cashew nut (pressed 2 x)	10	9.4 (Nx5.30)	49.5	105.9	56.5	114.3	183.3	17.25	3.28 ± 0.23	4.3	68
F. Canarium nut (pressed 2 x)	10	10.4 (Nx5.30)	49.5	97.1	47.6	96.6	183.3	19.12	2.49 ± 0.18	3.4	54
G. R i c e	10	6.2 (Nx5.95)	49.9	68.7	18.8	37.7	148.2	9.20	1.98 ± 0.58	3.9	63
H. Rice + Soy	10	9.7 (Nx5.83)	49.9	117.4	67.5	135.3	224.1	21.63	3.12 ± 0.28	3.9	63
I. Coconut Gratings + Soy	5	9.7 (Nx5.43)	49.6	96.6	46.8	93.8	160.9	15.56	3.00 ± 0.31	4.1	66

ADDENDUM
Table: 3

Results of Net Protein Utilization - Standard Determinations of Coconut gratings, Coconut Flakes, Cashew and Canary Nuts.

XP - Diet	Nitrogen cont. XP-diets as analysed	Protein	Avg at End of Exp.(10 days)		Group Body N		Group N - intake		Net Protein Utilization		Digesti-bility		Biological Value	
			Food-intake	Weight Increm.	Indiv. value	Avg	Indiv. value	Avg	Indiv. value	Avg	Indiv. value	Avg	Indiv. value	Avg
	g%	g%	g	%	grams		grams							
1. Skim Milk	1.494	9.53 (Nx6.38)	223.5	23.7	7.78 7.52 7.13 7.49	7.48	3.54 3.10 3.21 3.47	3.33	73 76 72 75	74	99 96 99 93	97	74 79 73 81	78
2. Desiccated Coconut TINA (pressed 2x)	1.785	9.46 (Nx5.30)	154.9	11.8	7.61 7.24 6.37 6.94 6.70	6.97	3.19 2.80 2.41 2.81 2.65	2.77	76 75 64 73 69	71	94 94 83 84 76	86	81 80 77 87 91	83
3. Coconut Flakes TINA (factory-pressed	1.685	8.93 (Nx5.30)	274.8	34.2	8.77 8.60 8.76 8.05 7.96	8.43	4.45 5.13 4.42 4.66 4.57	4.65	80 66 82 69 67	73	84 79 86 80 82	82	96 85 95 86 82	89
4. Cashew Nut (pressed 2x)	1.496	7.93 (Nx5.30)	247.8	38.4	7.52 6.60 7.25 7.39 7.49 7.11	7.23	3.62 3.27 3.88 3.96 3.77 3.73	3.71	77 78 78 75 74 77	77	88 93 88 100 86 95	92	88 84 89 74 86 81	84
5. Canary Nut (pressed 2x)	1.703	9.02 (Nx5.30)	221.6	26.3	6.54 6.47 7.12 6.96 7.11 6.62	6.80	3.57 3.53 4.03 3.83 3.99 3.70	3.78	59 67 64 66 60 64	63	88 86 93 94 88 100	92	67 78 68 70 68 64	69

ADDENDUM

Table : 4

Nitrogen and Protein content of pressed protein-rich materials used for the preparation of XP-Diet.

	Nitrogen %	Conversion Factor	Protein %
Coconut gratings, dried, laboratory prepared, pressed 1x	1.604	5.30	8.5
Desiccated coconut, (factory), (TINA), pressed 2x	2.081	5.30	11.0
Coconut Flakes (TINA), factory pressed.	3.283	5.30	17.4
Cashew nut, pressed 2x	4.377	5.30	23.2
Canarium nut, pressed 2x	6.695	5.30	35.5
Skim milk powder	5.643	6.38	36.0
Soy, boiled, dried, not dehulled	6.304	5.71	36.0
Rice (from market)	1.184	5.95	7.0

ADDENDUM
Table : 5

Composition in grams of Experimental Diets for P.E.R.- determination of various protein rich foodstuffs.

XP. 446 & XP. 470

Experimental Diets g/kg	Protein free diet	Skim-milk diet	Desicc. Coco-nut grat.	Coco-nut flakes TINA	Cashew nut	Canarium nut	Rice	Rice + Soy	Coconut grat. + Soy
Fat added	100	98	-	40	-	14	100	60	-
Starch	720	549	312	316	479	595	-	-	230
Glucose	150	50	-	50	50	50	-	50	50
Saltmixture	20	20	20	20	20	20	20	20	20
Celluflour	10	20	-	-	20	20	-	-	-
Vitamin mixture	+	+	+	+	+	+	+	+	+
Skim milk powder	-	263	-	-	-	-	-	-	-
Coconut grating, pressed 1x	-	-	668	-	-	-	-	-	558
Coconut flakes TINA	-	-	-	74	-	-	-	-	-
Cashew nut, pressed 2x	-	-	-	-	431	-	-	-	-
Canarium nut, pressed 2x	-	-	-	-	-	301	-	-	-
R i c e	-	-	-	-	-	-	880	728	-
Soy, boiled, dried	-	-	-	-	-	-	-	142	142
Total in grams:	1000	1000	1000	1000	1000	1000	1000	1000	1000
Nitrogen Content of XP- diet as analysed g%	-	1.485	1.094	1.887	1.774	1.962	1.042	1.664	1.786
Conversion factor	-	6.38	5.30	5.30	5.30	5.30	5.95	5.83	5.43
Protein Content of XP- diet g%	-	9.5	5.8	10.0	9.4	10.4	6.2	9.7	9.7

ADDENDUM
Table : 6

Composition of Experimental Diets
for NPU determination

Experimental Diets g/kg	Protein free diet	Skim-milk diet	XP.471-474 incl. Desicc. Coconut gratings TINA	XP.471-474 incl. Coconut flakes TINA	XP.435-440 incl. Cashew nut	XP.435-440 incl. Canarium nut
Fat added	100	98	-	38	-	55
Starch grits	720	549	70	378	569	600
Glucose	150	50	50	50	50	50
Salt mixture	20	20	20	20	20	20
Celluflour	10	20	-	-	20	20
Vitamin mixture	+	+	+	+	+	+
Skim milk powder	-	263	-	-	-	-
Desicc. Coconut gratings (TINA) (pressed 2x)	-	-	860	-	-	-
Desicc. Coconut Flakes (TINA)	-	-	-	514	-	-
Cashew nut, pressed 2x	-	-	-	-	341	-
Canarium nut, pressed 2x	-	-	-	-	-	255
Total in grams	1000	1000	1000	1000	1000	1000
Nitrogen Content of XP-diet as analysed g%	-	1.49	1.79	1.69	1.50	1.70
Conversion factor	-	6.38	5.30	5.30	5.30	5.30
Protein Content of XP-diet g%	-	9.53	9.46	8.93	7.93	9.02

ADDENDUM
Table : 7

Average Cumulative Weight Increase in percent and Average Total Food Intake in grams per rat by weeks during 4 weeks of Protein Efficiency Ratio determination of Coconut, Cashew and Canarium nut.

Experimental diet	Protein content of XP-diet g	Avg. weight at start g	Avg. Cumulative Weight increase in % at end of week no.				Avg. Total Food intake per rat by weeks during week.				Total of 4 weeks
			I %	II %	III %	IV %	I g	II g	III g	IV g	g
A. Protein free	0	50.3	-7.8	-12.1	-14.7	-17.2	18.7	17.0	14.6	14.4	64.8
B. Skim milk	9.5 (Nx6.38)	50.1	26.6	57.0	87.1	120.5	36.2	50.7	52.3	57.8	196.9
C. Coconut Gratings, dried (pressed 1 x)	5.8 (Nx5.30)	50.2	1.6	12.5	21.5	30.6	24.9	28.3	28.4	28.7	110.3
D. Coconut Flakes TINA	10.0 (Nx5.30)	49.8	28.8	63.0	96.0	126.2	41.4	54.8	57.0	54.6	207.8
E. Cashew nut (pressed 2x)	9.4 (Nx5.30)	49.5	31.8	60.4	91.2	114.3	42.6	47.3	48.5	47.9	183.3
F. Canarium nut (pressed 2x)	10.4 (Nx5.30)	49.5	19.9	47.7	73.5	96.6	37.7	47.8	49.9	47.8	183.3
G. R i c e	6.2 (Nx5.95)	49.9	8.9	21.8	31.3	37.7	38.0	38.9	37.6	33.7	148.2
H. R i c e + Soy	9.7 (Nx5.83)	49.9	33.7	73.5	111.4	135.3	51.1	60.9	59.8	52.3	224.1
I. Coconut Gratings + Soy	9.7 (Nx5.43)	49.6	25.1	50.4	74.4	93.8	36.5	43.1	42.2	39.0	160.9

Coconut products as a potential source of protein for the Indonesian diet.

A Preliminary Report.

Oey-Kam-Nio, Lie Goan-Hong, J. Herlinda and Risnawati Aminah

Unit Diponegoro-Nutrition Centre, Jakarta, from the :
National Institute for Health Research and Development,
Ministry of Health.

General Director : Prof.Dr.J. Soelianti Saroso

Coconut presscake as a by product of the oil factory is mainly sold for export as feed. As only the oil is extracted the protein is left in the presscake.

The Philippines and India have already done considerable research on the recovery of the protein from coconut intended for human use. It has become apparent that the protein is of good quality.

Already in 1966 our Unit Diponegoro started with the determination of the Net Protein Utilization value of the protein of coconut meat and copra meal, but it was discontinued. Only when in the beginning of 1977 desiccated coconut flour and coconut meal or presscake as flakes became available in sufficient quantities, these experiments were continued and they are still in progress.

The purpose of this article is to present the obtained NPU-values, although they are far from sufficient to allow for making any conclusion and also to promote the interest of foodtechnologists for the human use of coconut protein through the development of safer and modern food-products.

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held in Bogor, 21 - 23 June 1977.

Materials.

In 1966 ripe mature coconuts were bought from the market in Jakarta. The meat was finely grated with a simple household grater and carefully dried in the oven at low temperature. The dried product obtained was white in color and resembled desiccated coconut flour at present available in the free market. This dried grated coconut was taken to an oil factory in Jakarta, where most of the oil was pressed out. The product after defatting retained its white color. Copra meal (presscake) from the same factory was also obtained.

Early in 1977 grated desiccated coconut from a big modern desiccated coconut factory in North Sulawesi became available in sufficient quantity for our use. Coconut flakes were also received from the same factory at the same time. These flakes are the pressed residue of desiccated coconut flour after extracting the oil. Desiccated coconut flour which do not pass the requirement for export are treated in this way. These coconut flakes are light yellowbrown in color, have a good acceptable taste and flavor but are sold locally in North Sulawesi for feed. No technological information on the preparation of both products are at present available to us.

To make the desiccated coconut flour suitable for experimental diets, the oil content had to be reduced by extraction with ether, so that the protein content also became high (15.6 %). This was necessary to enable to compose a diet containing 10 % coconut protein with 10 % fat. For comparison roasted ground sound peanut was chosen. The oil was pressed out between layers of fat absorbing papers by means of manual pressure using a rolling bottle. This treatment was done repeatedly until found sufficient. Due care was taken that at the end of treatment the total sample was mixed thoroughly.

Methods.

Values for Net Protein Utilization were obtained using young weanling rats according to the method of Miller & Bender (1, 2).

The experimental diets were prepared in such a way that the protein content was approximately 10 % and the fat content 10 % if possible, so that the diets were approximately isocaloric.

Results :

a). Chemical analysis of the original material used :

I t e m per 100 gram	Protein	F a t	Carbo-hydrate "by difference"	Moisture	Minerals
	g	g	g	g	g
Grated Pressed coconut (1966)	15.6	30.1	42.1	8.4	3.8
Copra meal (presscake) (1966)	20.2	15.0	46.8	12.0	6.0
Desiccated Coconut flour	7.5	66.9	21.8	2.0	1.8
Coconut flakes	20.6	10.7	59.0	4.3	5.4
Roasted peanut	28.3	51.4	14.5	3.2	2.6

b) NPU-standard determinations :

Protein content of diet 10 %	Weight increase at end of Exp. (10 days) % of starting weight	N P U observed individual values				N P U average
1. Skim milk powder	35.2	76	79	78	73	77
2. Grated Pressed Coconut(1966)	20.5	64	70	77	67	70
3. Copra meal (1966)	18.9	63	62	67	70	66
4. Desiccated Coconut	29.4	77		81		79 (?)
5. Coconut flakes	37.1	77	67	71	74	71
6. Defatted roasted peanut	24.6	44	45	45	46	45

Discussion of results.

The grated pressed coconut and copra presscake (from 1966) have an average NPU-standard values of 70 and 66 respectively. The average value for the desiccated fat extracted coconut flour is 79, an average based on 2 values only and which is probably too high, more experiments are needed. The coconutflakes have an average NPU-standard value of 71. The NPU values of these coconut products are above 60, a value which indicates that the protein does not belong to the proteins of inferior quality.

Amino acids content of the desiccated coconut flour and coconut flakes from North Sulawesi are not yet available.

General discussion.

The general use of fresh coconut is wellknown in Indonesia. Coconut milk is wellknown as a component of many Indonesian dishes. The residue after preparing the coconut milk may be used in other recipes and is not always thrown away for feed or manure. This may especially be the case in the socio-economically underprivileged households both urban as well as rural.

In the village coconut oil may be prepared with grass-root technology, or by ordinary houschold methods, by skimming off the cream of the coconut milk after standing and then evaporating the water through heating in an open vessel.
The brown residue known as "galendo" (Sunda), "klendo or ketek" (Central Java), "tahi minyak" (3), is used as a seasoning of the rice dish. This "tahi minyak" will contribute some protein to the diet, but certainly this protein must be of low biological value due to too long heating.

Tempeh bongkrek made from fresh coconut residue or coprameal, is relished by the population in Central Java, notwithstanding the risk of poisoning due to improper fermentation process.

Coconut protein proves to have a good biological value and if consumed in sufficient amount, it may contribute to the improvement of the nutritive value of the Indonesian diet. With this in mind, the question arises what role does tempeh bongkrek play in the daily diet of the population ?

As it is consumed in not negligible amount, it must therefore have due attention and consideration of both nutritionists as well as food-technologists to make it a safe product.

Modern technology is looking now for more efficient use of the coconut meat in all its aspect. A report from the Philippines by Hagenmaier et al on aqueous processing of fresh coconuts for recovery of oil and coconut skim milk is already published in 1974. They have succeeded in preparing spray-dried coconut skim milk powder with a low fiber content. This coconut skim milk may be used in the formulation of an acceptable beverage and other food products (4,5). which seems very promising indeed.

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