

# Content of some nutrients in raw and prepared beef and lamb

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This presentation is a summary of two papers published in Norwegian in 1968 and 1969. Also included are some unpublished data from a research project completed in March 1969.

The purpose of these experiments was as follows:

To find a relationship between the content of B-vitamins, thiamine, riboflavin and niacin and the protein content of raw beef and lamb according to Watt and Merrill (26).

Further we were interested in studying any possible differences in the B-vitamin content between the most common breeds of Norwegian sheep, and if the pasture influenced the vitamin content. A literature survey has been carried out and a list of references is given. This revealed that no study had been undertaken in this country to clarify the influence of household preparations on the nutrient content of meat. Thus we found it necessary to follow these changes.

Beef were roasted<sup>1)</sup> and boiled, and lamb were roasted, braised and boiled.

## SELECTION OF MATERIAL

The carcasses chosen for analyses have been first grade quality in accordance with the consumers demands for retail meat. In order to get the most representative samples from each type of animal, the carcasses were selected by skilled graders, and cut according to the Norwegian standard of cutting, see fig. 1 and 2. The shaded areas indicate the cuts analysed.

<sup>1)</sup> The term »roast» is used here exclusively to designate meat cooked in the oven in an uncovered pan without the addition of water

The following carcasses were analysed

Kind of animal, no.	Age (days)	Weight (kg.)	Kind of animal no.	Age (days)	Weight (kg.)
<i>Bull</i>			<i>Lamb</i>		
			Dalabreed		
2610 .....	570	201,3	472	153	18,6
3813 .....	480	207,6	494	157	15,6
4216 .....	420	156,2	496	154	14,4
5607 .....	360	210,0	510	164	18,2
<i>Lamb</i>			<i>Lamb</i>		
Ryggjabreed			Sjeviotbreed		
31 .....	159	17,6	1038	All ca. 170	20,5
35 .....	154	14,4	1078		19,5
41 .....	155	13,2	1199		17,5
42 .....	166	14,1	1299		19,5
			Spelbreed		
44 .....	159	17,5			
2245 .....	161	18,7	908	184	17,9
2280 .....	166	20,5	964	180	19,1
2283 .....	171	15,1	975	175	16,5
2290 .....	164	17,9	977	180	16,4

## EXPERIMENTAL PROCEDURE

### *Preparation of samples*

Cuts from the right side of the carcass were analysed raw. Corresponding cuts from the left side were prepared and analysed. The following methods of preparation were studied. Each method was repeated at least three times.

### *Beef*

#### 1. Roasting

The oven thermostat was set at 180° C.

a) »Kam», »mörbrad» and »lårskive» (see fig. 1) were roasted till an internal meat temperature of 75° C, corresponding to well done.

b) »Mörbrad» was roasted till an internal temperature of 71° C, corresponding to medium done.

c) »Mörbrad» was roasted till an internal temperature of 60° C, corresponding to rare.

## 2. Boiling

The cut »bryst» was boiled completely immersed in water, using  $1\frac{1}{2}$  litres pr. kg meat. This method is described in Kokebok, Statens lærerskole i husstell (24). The cooking was continued until the meat was judged tender.

## Lamb

### 1. Roasting

- a) »Stek» and »kam» (see fig. 2) were roasted till internal temperature  $80^{\circ}\text{C}$ . The oven thermostat was set at  $150^{\circ}\text{C}$ .
- b) »Stek» and »kam» were roasted till internal temperature  $80^{\circ}\text{C}$ . The oven thermostat was set at  $170^{\circ}\text{C}$ .
- c) »Stek» was roasted till internal temperature  $95^{\circ}\text{C}$ . The oven thermostat was set at  $170^{\circ}\text{C}$ . The roast was cooled, wrapped, in aluminium foil and kept in the cold till the following day. It was then sliced, rewrapped in foil and heated over steam in the oven.

### 2. Braising

»Stek» was browned at  $200^{\circ}\text{C}$ , boiling water (0,5 litres) was subsequently added and the oventemperature reduced to  $170^{\circ}\text{C}$ . The cut was taken out of the oven when the internal meat temperature had reached  $80^{\circ}\text{C}$ .

### 3. Braising in an open pan

A heavy aluminium pan of internal diameter 26 cm and volume 7,5 l was used.

The cut was browned in 25 grams of margarine whereupon 0,5 liters of boiling water was added. The cooking was discontinued when the internal temperature of the meat had reached  $80^{\circ}\text{C}$ .

### 4. Boiling in an open pan at normal pressure

»Bog» and »side» were prepared as stew (24), the water barely covering the meat. The cooking was continued until the meat was judged tender.

### 5. Boiling in a pressure-cooker

»Bog» and »side» were prepared as stew (24), using an aluminium pressure-cooker of diameter 20 cm, volume 5 litres. The amount of water used, 0,5 litres, barely covered the bottom rack.

During the preparations the tempratures in the meat and oven were measured by means of thermocouples.

The roasts, the boiled meat, the drippings and the stock were weighed

immediately after preparation and when cooled. Fat was removed from drippings and stock before analyses.

## ANALYTICAL METHODS

**Water:** As described by Morris B. Jacobs, 1951 (10).

**Protein:** Kjeldahl — Gunning — Arnolds method (10).

**Fat and ash:** Method no. 23 recommended by Nordisk Metodikk — Komité' for Næringsmidler.

**Calcium:** Method no. 21 recommended by Nordisk Metodikk-komite' for Næringsmidler.

**Iron:** Method no. 22 recommended by Nordisk Metodikk-komite' for Næringsmidler.

**B-vitamins.** Microbiological methods were used for the determination of thiamine, riboflavin and niacin.

The thiamine content is determined by using a method described by Barton Wright (1), whereas the riboflavin and niacin content was determined using methods as described in Vitamin Methods, 1950 (7) and Methods of Vitamin Assay, 1951 (25).

Norwegian standard method of cutting

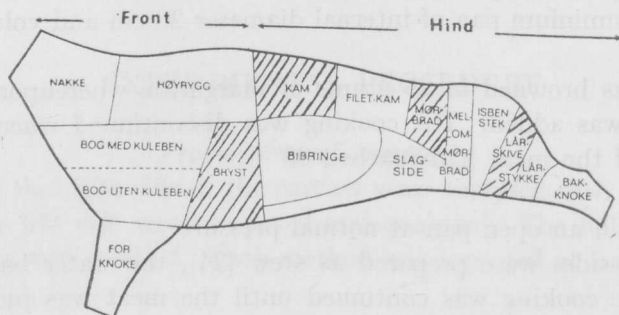


Fig. 1 Beef

## RESULTS AND DISCUSSION

### Beef

The nutritive value and food energy of raw and prepared beef are given in Table.

As expected it was found that in the case of a relatively fat carcass, even

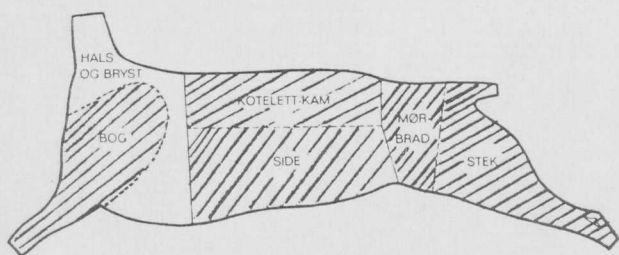


Fig. 2 Lamb

The shaded cuts were analysed

if classified »medium fat», there were large variations in the fat content between the different cuts. »Lårskive» from bull 2610 analysed raw contained 6,4 grams of fat pr. 100 grams of edible meat, while the cut »bryst» contained 28,9 grams of fat pr. 100 grams of edible meat.

The calcium content of raw meat varied somewhat. Some cuts contained twice as much as others. This may be explained by the fact that small cartilage or bone fragments can be mixed in with the meat during preparation of the sample.

It was found that the iron content varied fra 1,2 to 2,7 mg pr. 100 grams of meat.

Our data on the B-vitamin content of raw meat are in good agreement with figures reported in the literature. See Table 1.

Calculations using the data obtained along with data published earlier show that the following factors may be used for estimating vitamin content of raw beef:

Thiamine	0,0045 milligram per gram of protein
Riboflavin	0,0087 milligram per gram of protein
Niacin	0,23 milligram per gram of protein.

The weight loss in the meat due to the preparation is given in Table 4 and is calculated as follows.

$$\frac{\text{Raw meat} + \text{water (if added)} - \text{Prepared meat} + \text{drippings} \times 100}{\text{Raw meat} + \text{water (if added)}}$$

The retention of thiamine, riboflavin and niacin for the four methods of preparation is given in Table 5. The retention is considerably lower in the boiled meat than in the roasted meat. The thiamine retention in boiled meat is especially low. Drippings is a good source of B-vitamines.

Table 1. *Medium fat bulls, Grade 1. Nutrients and Food Energy in the Edible Portion of 100 grams of Meat.*

Cut	Weight of trimmed cut kg	Edible %	Water g	Protein g	Fat g	Food energy k.cal	Ash g	Cal- cium mg	Iron mg	B-vitamins		
										Thia- mine mg	Ribof- lavin mg	Niacin mg
<i>Raw meat</i>												
Kam .....	5,925	77	69,9	20,7	8,4	159	1,0	9	1,7	0,08	0,16	5,0
Mörbradstek .....	4,095	77	72,5	19,6	5,2	125	1,1	7	2,2	0,11	0,20	5,4
Lårskive .....	5,525	95	74,0	20,1	3,1	109	1,1	6	1,9	0,10	0,17	4,7
Bryst .....	8,595	76	67,7	18,8	11,7	181	1,0	7	1,7	0,09	0,19	4,3
<i>Prepared meat</i>												
Roasted till well done.												
Kam .....	5,986	—	53,6	26,5	18,2	269	1,2	18	2,1	0,06	0,17	3,9
Mörbradstek .....	3,963	—	55,2	27,6	14,8	244	1,1	8	2,5	0,09	0,23	4,3
Lårskive .....	5,460	—	59,0	29,8	9,4	204	1,0	7	2,2	0,08	0,19	4,1
Boiled												
Bryst .....	8,738	—	50,5	22,6	24,2	308	0,7	19	1,8	0,02	0,17	2,1
<i>Drippings from<sub>1</sub>)</i>												
Kam .....	—	—	52,8	22,1	—	—	—	—	—	0,13	0,41	11,4
Mörbradstek .....	—	—	62,6	21,3	—	—	—	—	—	0,26	0,73	22,6
Lårskive .....	—	—	86,4	7,1	—	—	3,4	6	0,7	0,20	0,25	7,3
<i>Stock from<sub>1</sub>)</i>												
Bryst .....	—	—	97,7	1,3	—	—	0,9	2	0,2	0,02	0,04	1,0

<sub>1</sub>) Fat removed.

Table 1. *Continued.*

*Nutrients and Food Energy in the Edible Portion of 100 grams of Meat.*

<i>Cut</i>	<i>Weight of trimmed cut kg</i>	<i>Edible %</i>	<i>Water g</i>	<i>Protein g</i>	<i>Fat g</i>	<i>Food energy k.cal</i>	<i>B-vitamins</i>		
							<i>Thia-mine mg</i>	<i>Ribo-flavin mg</i>	<i>Niacin mg</i>
<i>Raw meat</i>									
»Mörbradstek» .....	3940	67,4	66,0	18,7	12,8	190	0,08	0,15	4,8
<i>Prepared meat</i>									
Roasted till medium done »Mörbradstek» ....	4465	—	59,2	26,0	12,6	217	0,08	0,14	4,5
Drippings from »mörbradstek».....	—	—	64,1	20,6	—	—	0,15	0,61	28,0
Roasted til rear done »Mörbradstek» .....	3370	—	60,0	23,8	14,0	221	0,09	0,14	5,0
Drippings from »mörbradstek» .....	—	—	50,3	17,6	—	—	0,22	0,53	28,8

\* Duplicat.



Table 2. *Nutrients and Food Energy in the Edible Portion of 100 grams of Meat.*

<i>Breed/Cut</i>	<i>Edible</i> %	<i>Water</i> g	<i>Protein</i> g	<i>Fat</i> g	<i>Food</i> <i>energy</i> k.cal	<i>Ash</i> g	<i>Calcium</i> mg	<i>Iron</i> mg	<i>B-Vitamins</i>		
									<i>Thia-</i> <i>mine</i> mg	<i>Ribo-</i> <i>flavin</i> mg	<i>Niacin</i> mg
<i>Dalabreed</i>											
Stek .....	82	65,2	18,2	15,3	211	0,9	7	1,7	0,17	0,27	6,8
Kam .....	74	60,3	16,9	22,2	267	0,9	11	1,4	0,16	0,24	6,5
Bog .....	74	65,4	16,9	16,2	213	1,0	10	1,4	0,15	0,24	5,8
Side .....	87	60,7	16,2	21,8	261	0,9	9	1,2	0,12	0,19	5,0
<i>Sjeviotbreed</i>											
Stek .....	83	65,2	17,7	16,0	215	1,1	7	1,9	0,21	0,23	7,0
Kam .....	77	55,3	16,2	27,4	311	0,9	12	1,5	0,17	0,20	6,2
Bog .....	78	61,3	16,8	19,3	241	0,9	11	1,5	0,15	0,23	5,1
Side .....	89	54,7	15,0	31,6	344	0,8	9	1,4	0,10	0,17	4,5
<i>Spelbreed</i>											
Stek .....	81	65,7	18,6	15,6	215	1,1	6	1,6	0,21	0,24	7,0
Kam .....	74	57,7	16,6	25,7	298	0,9	13	1,5	0,16	0,19	6,0
Bog .....	74	64,7	17,4	17,0	223	1,0	12	1,6	0,14	0,21	5,8
Side .....	87	54,4	15,1	30,7	337	0,8	9	1,3	0,11	0,15	4,4



Table 2 continued. *Nutrients and Food Energy in the Edible portion of 100 grams of Meat.*

<i>Breed/Cut</i>	<i>Edible</i> %	<i>Water</i> g	<i>Protein</i> g	<i>Fat</i> g	<i>Food</i> <i>energy</i> k.cal	<i>Ash</i> g	<i>Cal-</i> <i>cium</i> mg	<i>Iron</i> mg	<i>B-Vitamines</i>		
									<i>Thia-</i> <i>mine</i> mg	<i>Ribo-</i> <i>flavin</i> mg	<i>Niacin</i> mg
<i>Ryggjabreed</i>											
Uncultivated mountain pasture											
Stek .....	81	65,4	17,6	16,1	215	1,0	5	1,5	0,24	0,28	6,0
Kam .....	73	60,0	16,9	22,3	268	0,9	7	1,5	0,22	0,23	6,2
Bog .....	73	65,0	17,7	16,7	221	1,0	8	1,4	0,19	0,23	5,1
Side .....	86	59,5	16,4	22,4	267	0,9	8	1,5	0,14	0,20	4,9
<i>Ryggjabreed</i>											
Cultivated pasture											
Stek .....	78	66,1	18,1	14,2	200	0,9	7	1,9	0,26	0,26	5,4
Kam .....	72	61,5	17,4	20,1	251	1,0	13	1,8	0,23	0,25	5,1
Bog .....	74	64,3	17,5	17,4	226	1,0	14	1,6	0,20	0,23	4,3
Side .....	85	62,9	16,6	19,1	238	1,0	9	1,8	0,15	0,19	4,1

PREPARED LAMB.

Table 3. *Nutrients and Food Energy in the Edible Portion of 100 grams of Meat.*

Method of preparation, cut	Water g	Protein g	Fat g	Food energy k.cal	Ash g	Cal- cium mg	Iron mg	-Vitamins		
								Thia- mine mg	Ribo- flavin mg	Niacin mg
<i>Lamb.</i>										
1. Roasting.										
a) Oventemp. 150° C till meattemp. 80° C										
»Stek» .....	56,4	24,6	16,9	251	1,1	7	2,3	0,19	0,27	5,6
»Kam» .....	51,8	21,6	26,1	317	1,0	16	1,9	0,19	0,17	4,8
Drippings from:										
»Stek» .....	84,4	—	—	—	—	—	—	0,61	0,41	16,2
»Kam» .....	80,2	—	—	—	—	—	—	0,74	0,28	16,0
b) Oventemp. 170° C till meattemp. 80° C										
»Stek» .....	55,4	24,4	18,7	266	1,2	16	2,4	0,20	0,20	3,9
»Kam» .....	53,6	25,3	23,7	299	1,2	21	2,0	0,18	0,17	4,1
Drippings from »Stek» .....	83,1	—	—	—	—	—	—	0,49	0,42	13,5
c) Oventemp. 170° C till meattemp. 95° C										
»Stek» .....	51,2	30,3	16,8	272	1,2	9	3,1	0,13	0,27	6,3
Drippings from »Stek» .....	85,6	—	—	—	—	—	—	0,41	0,52	23,5
2. Braising.										
Oventemp. 200/170° C till meattemp. 80° C										
»Stek» .....	56,1	24,6	17,6	257	1,0	8	2,5	0,19	0,24	5,5
Drippings from »Stek» .....	90,6	—	—	—	—	—	—	0,22	0,22	9,1
3. Braising in an open pan Meattemp. 80° C										
»Kam» .....	51,9	22,5	24,2	305	1,0	15	1,9	0,19	0,20	5,2
Drippings from »Kam» .....	97,0	—	—	—	—	—	—	0,10	0,05	2,7
4. Boiling in an open pan										
»Bog» .....	50,9	24,9	23,2	308	0,8	23	2,1	0,10	0,15	2,9
»Side» .....	52,2	21,3	25,5	315	0,8	17	2,1	0,08	0,12	2,6
Stock from »Bog» .....	96,3	—	—	—	—	—	—	0,09	0,06	4,3
» » »Side» .....	97,2	—	—	—	—	—	—	0,07	0,06	2,7
5. Boiling in a pressure cooker										
»Bog» .....	41,1	26,2	21,1	295	1,0	21	2,2	0,11	0,17	3,9

Table 4. *Weight loss and preparation time of beef and lamb.*

Method of preparation, cut.	Weight loss in meat %		Preparation time pr. kg Minutes	
	Mean	Variation	Mean	Variation
<i>Beef</i>				
1. Roasting.				
a) Oventemp. 180° C till meattemp. 75° C				
»Kam» .....	23,5	21,0—25,9	36	32—42
»Mörbrad» .....	26,7	26,4—28,3	44	43—45
»Lårskive» .....	24,9	27,4—31,6	23	20—29
b) Oventemp. 180° C till meattemp. 71° C				
»Mörbrad» .....	23,9	20,1—26,9	40	34—48
c) Oventemp. 180° C till meattemp. 60° C				
»Mörbrad» .....	21,2	16,7—26,9	35	29—43
2. Boiling in an open pan.				
»Bryst» .....	27,7	26,0—29,4	151	145—160
<i>Lamb</i>				
1. Roasting.				
a) Oventemp. 150° C till meattemp. 80° C				
»Stek» .....	27,7	25,4—28,9	76	70—86
»Kam» .....	20,1	17,3—22,3	72	69—74
b) Oventemp. 170° C till meattemp. 80° C				
»Stek» .....	30,7	27,3—33,5	66	60—74
»Kam» .....	22,1	18,6—31,3	62	56—65
c) Oventemp. 170° C till meattemp. 95° C				
»Stek» .....	41,9	41,4—43,0	97	81—110
2. Braising.				
Oventemp. 200/170° C till meattemp. 80° C				
»Stek» .....	32,3	31,6—33,1	61	53—57
3. Braising in an open pan Meattemp. 80° C				
»Kam» .....	22,6	18,7—26,5	51	47—53
4. Boiling in an open pan				
»Bog» .....	30,0	27,4—33,4	67	58—79
»Side» .....	29,0	27,1—31,7	92	75—114
5. Boiling in a pressure cooker				
»Bog» .....	35,3	33,3—37,7	19	
»Side» .....	37,0	35,1—40,7	19	

Table 5. Retention of B-Vitamins.

Method of preparation, cut.	Thiamine %		Riboflavin %		Niacin %	
	in the meat	total	in the meat	total	in the meat	total
<i>Beef.</i>						
a) Oventemp. 180° C till meattemp. 75° C						
»Kam» .....	54	61	79	90	59	67
»Mörbrad» .....	57	64	83	97	58	69
»Lårskive» .....	52	71	76	98	60	84
b) Oventemp. 180° C till meattemp. 71° C						
»Mörbrad» .....	69	72	71	76	72	79
c) Oventemp. 180° C till meattemp. 60° C						
»Mörbrad» .....	82	84	74	77	83	88
2. Boiling in an open pan.						
»Bryst» .....	16	50	62	96	35	63
<i>Lamb.</i>						
1. Roasting.						
a) Oventemp. 150° C till meattemp. 80° C						
»Stek» .....	59	77	70	80	59	75
»Kam» .....	86	93	64	64	67	73
b) Oventemp. 170 °C till meattemp. 80° C						
»Stek» .....	54	67	54	66	50	68
»Kam» .....	64	—	51	—	63	—
c) Oventemp. 170° C till meattemp. 95° C						
»Stek» .....	37	—	70	—	53	—
2. Braising.						
Oventemp. 200/170° C till meattemp. 80° C						
»Stek» .....	72	85	69	81	58	75
3. Braising in an open pan. Meattemp. 80° C						
»Kam» .....	75	93	72	82	63	86
4. Boiling in an open pan.						
»Bog» .....	34	49	48	60	47	73
»Side» .....	35	59	45	62	45	80
5. Boiling in a pressure cooker.						
»Bog» .....	40	66	47	64	47	77
»Side» .....	35	55	49	64	50	84

### Lamb

The nutritive values and food energy of raw lamb is given in Table 2, and for prepared in Table 3.

The fat content varied considerably from cut to cut within the same carcass. The fat contents of »stek» and »bog» were similar and these were considerably lower than that of »kam» and »side». A significant difference between the B-vitamin content of different cuts was found.

No distinct difference was observed between the content of thiamine, riboflavin and niacin in different breeds of lamb. Further the influence of pasture seemed to be negligible.

Calculations using the data obtained along with data published earlier show that the following factors may be used for estimating vitamin content of raw lamb.

Thiamine	0,0114 milligram per gram of protein
Riboflavin	0,0128 milligram per gram of protein
Niacin	0,32 milligram per gram of protein

The weight loss in the meat due to preparation is given in Table 4.

Retention of thiamine, riboflavin and niacin for the different methods of preparation is listed in Table 5.

Wide variations in the retention values were found.

### LITERATUR

1. Barton-Wright, E. C. Practical methods for the microbiological assay of the vitamin B-complex and amino acids. London, United Trade Press Ltd., 1961.
2. Blegen, E. og Damm, A. Innhold av endel næringsstoffer i kjøtt av storfe, sau og gris. Statens forsøksvirksomhet i husstell, Stabekk og Norges Slakterilaboratorium, Oslo, 1966. 36 s.
3. Blegen, E. Næringsverdi i rått og tilberedt storfekjøtt. Statens forsøksvirksomhet i husstell, Bekkestua. Melding nr. 20, 1968. 20 s.
4. Cover, S., Dilsaver, E. M. and Hays, R. M. Retention of B-vitamins after large-scale cooking of meat. I. Suitability of left and right muscles for retention studies. Food Res., 1948, 13, 472—474.
5. Cover, S., Dilsaver, E. M. and Hays, R. M. Variation among lamb carcasses in B-vitamin content of meat. Science, 1947, 105.
6. Cover, S. and Smith, W. H. Variation in thiamine and niacin content of raw lamb muscle. J. Animal Sci., 1955, 14, 173.
7. György, P. Vitamin Methods. New York, Academic Press Inc., Pub. 1950.
8. Hjarde, W. Statens Vitamin-laboratoriums undersøgelser av B<sub>1</sub>-vitaminindholdet i danske næringsmidler. Statens Husholdningsråds Faglige Meddelelser, 1955, 9—16.
9. Hjarde, W. og Lieck, H. Statens Vitamin-laboratoriums undersøgelser av B<sub>2</sub>-vitaminindholdet i danske næringsmidler. Statens Husholdningsråds Faglige Meddelelser, 1957, 9—16.
10. Homb, E. og Offergaard, E. Innhold av endel næringsstoffer i kjøtt og kjøttvarer. Statens forsøksvirksomhet i husstell. Melding nr. 10, Forskning og forsøk i landbruket, 1957.
11. Jacobs, M. B. The chemical analysis of food and food products. 2. ed. New York, D. Van Nostrand Company, Inc., 1951.

12. Kiernat, B. H., Johnson, J. A. and Siedler, A. J. A summary of the nutrient content of meat. American Meat Institute Foundation. Bulletin No. 57, Chicago, 1964. 38 s.
13. Leverton, R. M. and Odell, G. V. The nutritive value of cooked meat. Oklahoma State University, MP-49, 1958. 90 s.
14. Lieck, H. Statens Vitamin-laboratoriums undersøgelser av nikotinsyreindholdet i danske næringsmidler. Statens Husholdningsråds Faglige Meddelelser, 1954, 41-46.
15. Lushbough, C. H., Heller, B. S., Weir, E. and Schweigert, B. S. Thiamine retention in meats after various treatments. J. Amer. Dietetic. Assoc., 1962, 40, 35-38.
16. McIntire, J. M., Schweigert, B. S. and Elvehjem, C. A. The retention of vitamins in veal and lamb during cooking. J. Nutrition, 1943, 26, 621-629.
17. Merrill, A. L., Adams, C. F. and Fincher, L. J. Procedures for calculating nutritive values of home-prepared foods. United States Department of Agriculture, 1963, 35 s.
18. Noble, I. and Gomez, L. Thiamine and riboflavin in roast beef. J. Amer. Dietetic Assoc., 1960, 36, 46-48.
19. Noble, I. and Gomez, L. Thiamine and riboflavin in roast lamb. J. Amer. Dietetic Assoc., 1958, 34, 157-159.
20. Nordisk Metodikk-komit  for Næringsmidler. Metode nr. 21, 1955.
21. Nordisk Metodikk-komit  for Næringsmidler. Metode nr. 22, 1955.
22. Nordisk Metodikk-komit  for Næringsmidler. Metode nr. 23, 1955.
23. Pecot, R. K., Jaeger, C. M. and Watt, B. K. Proximate composition of beef from carcass to cooked meat: Method of derivation and tables of values. United States Department of Agriculture. Home Economics Research Report No. 31, 1965. 31 pp.
24. Statens lærerskole i husstell, Stabekk. Kokebok. Ny utg. ved Ragna R. Kjørven og Ingrid Sandkleiva. Red. Olga Ambjørnrud. 9. oppl. Oslo, J. W. Cappelens forlag, 1961.
25. The association of vitamin chemists, Inc. Methods of vitamin assay. 2. ed. New York, Interscience, Pub., Inc., 1951. 301 pp.
26. Watt, B. K. and Merrill, A. L. Composition of foods - raw, processed, prepared. United States Department of Agriculture. USDA Agric. Handbook No. 8, 1963.
27. Wilcox, E. B. and Galloway, L. S. The B Vitamins in raw and cooked lamb. I. Thiamine. Food Res., 1952, 17, 67-73.
28. Wilcox, E. B. and Galloway, L. S. The B Vitamins in raw and cooked lamb. II. Riboflavin and Niacin. Food Res., 1952, 17, 144-147.