COOKING YIELDS AND NUTRIENT RETENTION FACTORS OF BACON, LIVER, AND SAUSAGES

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ABSTRACT

Objective: In the past, the USDA Nutrient Data Laboratory released a special table of nutrient retention factors. Recently, the nutrient database processing software (AIM_NDBS) was updated to include an improved nutrient retention module as well as a cooking yields module. Yield and retention studies have recently been conducted on bacon, liver and sausages. The objective of the studies reported here was to analyze and determine nutrient values, cooking yields and nutrient retention factors for bacon, liver (beef, calf and chicken livers) and sausages. **Methods and Materials:** The products analyzed were obtained from 12 nationwide retail outlets through the National Food and Nutrient Analysis Program (NFNAP). All food items were analyzed raw and cooked. Bacon was baked, microwaved, and pan-fried. The livers were pan-fried or braised. The fresh sausages were pan-fried. Smoked pork and beef sausages were analyzed as purchased. Precooked sausages were analyzed after heating. Nutrient analyses including proximates, cholesterol, trans fatty acids, iron, zinc, thiamin, niacin, riboflavin, and vitamins K, B_6 and B_{12} were conducted by a commercial laboratory. Nutrient data and weights were processed through the yields and retentions module of AIM_NDBS. **Results:** Yields varied according to trimming and cooking method. For example, baked and pan-fried bacon averaged a 31% cooking yield and microwaved bacon averaged a 26% cooking yield. While a few retentions were updates of existing ones, most retention factors were completely new and will be reported. **Significance:** The advent of the new yields and retentions module to the AIM_NDBS system streamlined the process of calculating cooking yields and nutrient retention factors from nutrient data. The recent studies performed on bacon, liver and sausages afforded an opportunity to update nutrient data, cooking yields and nutrient retention factors within a relatively short period of time. Yield and retention data will be used in food service operations, the food industry, universities and government agencies. These new cooking yields and nutrient retention factors will enlarge the nutrient database scope of food items from which users will be able to estimate data for cooked foods.

INTRODUCTION

The Nutrient Data Laboratory's (NDL) Nutrient Database processing software (AIM_NDBS) has been updated and includes both an updated nutrient retention module and a cooking yields module. Recognizing a future need for updated and additional nutrient retention factors and cooking yields, NDL has conducted several studies on meat products. Items analyzed in the current study include: bacon, beef, calf and chicken livers and various sausages. This study provides an update to existing nutrient data and adds new food products to the database, and provides new information for the calculation of nutrient retention factors and cooking yields.

OBJECTIVES

To analyze and determine the nutrient values, nutrient retention factors and cooking yields of bacon, livers, and various sausages

METHODS AND ANALYSES

Sampling

- Nationally representative food samples were obtained from retail stores through the National Food and Nutrient Analysis Program (NFNAP) and locally in Maryland and Wisconsin
- Paired samples were taken from each package
- Samples were shipped to and prepared at the University of Wisconsin-Madison
- Samples were analyzed commercially through Covance Laboratories, Madison, Wisconsin

Cooking Procedures

Bacon
- Baked for 11 minutes at 204EC and cooled for 1 hour[1]
- Microwaved for 3 minutes, turned, microwaved for 2 ½ minutes and cooled for 1 hour
- Pan-fried for 3 minutes at 177EC, turned, pan-fried for 4 minutes, turned, pan-fried for 4 minutes and cooled for 1 hour

Livers
- Cooked to an internal temperature of 78EC – 85EC (7-11 minutes) and cooled for 5 minutes

Fresh sausages
- Pan-fried/no added fat at 149EC - 163EC to an internal temperature of 80EC - 83EC (15-25 minutes) and cooled for 5 minutes

Pre-cooked sausages
- Pan-fried/no added fat/water added at 149EC - 163EC to an internal temperature of 63EC - 68EC (5-8 minutes) and cooled for 5 minutes

[1]All food items were cooled at room-temperature

Nutrient Content of Bacon (g/100 g of food)

Product	Moisture	Protein	Total Fat	Ash	Carbohydrate
Bacon, raw	40.20	11.60	45.04	3.51	0.66
Bacon, baked	12.62	35.73	43.27	7.12	1.35
Bacon, microwaved	16.49	38.62	37.27	6.57	1.05
Bacon, pan-fried	12.12	38.34	40.30	7.74	1.50

Nutrient Content of Bacon (mg/100 g)

Product	Iron	Sodium	Zinc	Selenium (µg)	Phosphorous	Total Folate (µg)	Thiamin	Riboflavin	Niacin	Vitamin B_6	Vitamin B_{12} (µg)
Bacon, raw	0.480	833	1.170	20.200	188	2	0.281	0.113	3.828	0.210	0.690
Bacon, baked	1.490	2193	3.360	59.000	506	2	0.348	0.251	10.623	0.309	1.160
Bacon, microwaved	1.280	2073	3.700	65.800	480	2	0.598	0.250	10.150	0.433	1.580
Bacon, pan-fried	1.380	2428	3.640	65.000	561	2	0.459	0.277	11.575	0.389	1.300

Cooking Yields of Bacon, Livers and Sausages (%)

Product	Yield	Moisture Gain/Loss	Fat Gain/Loss
Bacon, baked	31.37	-36.27	-31.47
Bacon, microwaved	29.38	-35.36	-34.09
Bacon, pan-fried	30.55	-36.50	-32.73
Beef liver, braised	68.38	-30.60	-0.04
Beef liver, pan-fried	72.74	-25.71	-0.23
Calves liver, braised	68.97	-29.61	-0.54
Calves liver, pan-fried	62.51	-60.45	-0.46
Chicken liver, braised	64.07	-33.66	-0.66
Chicken liver, pan-fried	62.51	-35.70	-0.82
Beef, fresh sausage, pan-fried, link	76.30	-12.11	-6.63
Pork, fresh sausage, pan-fried, link	86.37	-13.23	-2.04
Turkey, fresh sausage, pan-fried, patty	102.42	-3.78	+2.61
Beef, sausage, pre-cooked	94.68	-2.33	-2.00
Pork, sausage, pre-cooked	93.13	-3.30	-2.41
Pork and turkey, sausage, pre-cooked	94.48	-2.80	-1.69

Nutrient Content of Liver (g/100 g of food)

Product	Moisture	Protein	Total Fat	Ash	Carbohydrate
Beef liver, raw	70.81	20.36	3.63	1.31	3.89
Beef liver, braised	58.81	29.08	5.26	1.74	5.13
Beef liver, pan-fried	62.01	26.52	4.68	1.63	5.16
Chicken liver, raw	76.46	16.92	4.83	1.06	0.72
Chicken liver, braised	66.81	24.46	6.51	1.36	0.87
Chicken liver, pan-fried	65.22	25.78	6.43	1.47	1.11
Calf liver, raw	70.89	16.92	4.85	4.85	2.91
Calf liver, braised	59.86	28.42	6.26	6.26	3.77
Calf liver, pan-fried	59.87	27.37	27.37	6.51	4.47

Nutrient Content of Liver (mg/100 g)

Product	Iron	Sodium	Zinc	Selenium (:g)	Phosphorous	Total Folate (:g)	Thiamin	Riboflavin	Niacin	Vitamin B_6	Vitamin B_{12} (:g)
Beef, liver, raw	4.900	69	4.00	39.700	387	290	0.189	2.755	13.175	1.083	59.300
Beef, liver, braised	6.540	79	5.30	36.100	497	253	0.194	3.425	17.525	1.017	70.580
Beef, liver, pan-fried	6.170	77	5.23	32.800	485	260	0.177	3.425	14.475	1.027	83.130
Chicken, liver, raw	8.990	71	12.02	54.600	297	588	0.305	2.440	9.728	0.853	16.580
Chicken, liver, braised	11.630	76	11.23	82.400	405	578	0.291	2.860	11.045	0.755	16.850
Chicken, liver, pan-fried	12.880	92	11.90	88.200	442	560	0.292	3.060	13.925	0.840	21.130
Calves, liver, raw	6.440	77	2.67	22.700	379	125	0.173	1.778	10.550	0.957	59.850
Calves, liver, braised	5.110	78	3.98	19.300	460	331	0.182	1.993	13.150	0.918	84.600
Calves, liver, pan-fried	5.980	85	4.01	24.900	483	350	0.178	2.313	14.350	0.891	72.500

Nutrient Content of Sausages (g/100 g of food)

Product	Moisture	Protein	Total Fat	Ash	Carbohydrate
Beef, fresh sausage, pan-fried	51.12	18.21	27.98	2.34	0.35
Pork, fresh sausage, raw	56.22	15.09	26.53	2.26	0.00
Pork, fresh sausage, pan-fried	49.78	19.43	28.36	2.76	0.00
Turkey, fresh sausage, raw	70.42	18.79	8.08	2.24	0.47
Turkey, fresh sausage, pan-fried	65.06	23.89	10.44	2.65	0.00
Beef, sausage, pre-cooked	43.75	15.50	37.57	3.16	0.03
Pork, sausage, pre-cooked	47.97	14.49	35.04	2.84	0.00
Pork and turkey, sausage, pre-cooked	50.68	12.05	30.64	3.01	3.63

Nutrient Content of Sausages (mg/100 g)

Product	Iron	Sodium	Zinc	Selenium (:g)	Phosphorous	Total Folate (:g)	Thiamin	Riboflavin	Niacin	Vitamin B_6	Vitamin B_{12} (:g)
Beef, fresh sausage, pan-fried	1.570	652	4.380	0	141	3	0.048	0.150	3.600	0.313	2.010
Pork, fresh, sausage, raw	1.110	636	2.170	0	135	1	0.275	0.122	4.703	0.306	0.850
Pork, fresh sausage, pan-fried	1.360	749	2.080	0	163	3	0.294	0.197	6.258	0.327	1.180
Turkey, fresh sausage, raw	1.170	593	3.060	0	177	5	0.077	0.234	4.600	0.431	1.300
Turkey, fresh sausage, pan-fried	1.490	665	3.800	0	202	6	0.084	0.255	5.720	0.322	1.230
Beef, sausage, pre-cooked	1.530	910	2.920	0	185	5	0.028	0.117	3.210	0.192	2.030
Pork, sausage, pre-cooked	0.920	752	1.500	0	275	1	0.208	0.156	4.050	0.149	0.710
Pork and turkey, sausage, pre-cooked	1.300	876	1.340	0	136	10	0.089	0.099	2.730	0.124	0.580

Nutrient Retention Factors of Bacon and Livers (%)

Product	Iron	Phosphorous	Sodium	Zinc	Selenium	Thiamin	Riboflavin	Niacin	Total Folate	Vitamin B_6	Vitamin B_{12}
Bacon, baked	97	88	83	90	92	39	70	87	42	46	53
Bacon, microwaved	78	75	73	93	96	63	65	78	34	61	68
Bacon, pan-fried	88	91	89	95	98	50	75	92	41	57	58
Beef liver, braised	100	100	92	100	74	83	100	100	71	76	96
Beef liver, pan-fried	100	100	100	100	77	87	100	100	83	88	100
Calves liver, braised	38	58	48	45	41	50	56	60	100	46	68
Calves liver, pan-fried	52	71	62	55	61	57	70	76	100	52	68
Chicken liver, braised	100	100	84	100	100	75	88	89	77	69	80
Chicken liver, pan-fried	100	100	100	100	100	75	100	100	75	77	100

CALCULATIONS AND FORMULAS

Fat Gain/Loss

$$\frac{(\%\text{fat ckd sample x wt (g) ckd sample}) - (\%\text{fat raw sample x wt (g) raw sample}) \times 100}{\text{g raw food}}$$

Moisture Gain/Loss

$$\frac{(\%H_2O\ \text{ckd sample x wt (g) ckd sample}) - (\%H_2O\ \text{raw sample x wt (g) raw sample}) \times 100}{\text{g raw food}}$$

Yield

$$\frac{\text{Cooked sample cooked weight} \times 100}{\text{Cooked sample raw weight}}$$

Retention

$$100 \times I^a \times \frac{\%I^b \times Wc^d}{\%I^a \times Wr^c}$$

[a]raw sample nutr w/ckd sample raw wt
[b]nutrient value per 100 g of cooked food
[c]nutrient value per 100 g of raw food
[d]weight in g after cooking
[e]weight in g before cooking

RESULTS

- Folate values for bacon were very low and approached a limit of detection. Consequently, retention values primarily reflect cooking yields.
- Thiamin retention for baked bacon was lower than for pan-fried and microwaved bacon in spite of similarities in cooking yields
- Beef liver and fresh sausages had greater retention of iron and phosphorous.
- Turkey sausage had a cooking yield of over 100% due to a fat gain.
- Cooking yields were consistently higher for precooked sausage products when compared to the respective fresh, cooked products.

SUMMARY

- Bacon had the lowest yield
- Thiamin in baked bacon was more labile due to a higher cooking temperature
- Beef and chicken livers had fairly equal retention values for most nutrients studied
- Calves liver had lower retention values when compared to beef or chicken livers
- Calves liver retention for folate, however, was 100%
- Fresh beef sausage had lower cooking yields, as well as moisture and fat loss, than pre-cooked beef sausage
- Apparent fat gain in turkey, fresh, sausage reflects nutrient concentration due to moisture loss
- Nutrient factors were similar for fresh cooked and precooked sausages, despite lower cooking yields for the fresh cooked product