Nutrient Composition in Ground Pork using Regression Techniques

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Abstract: New data on nutrient composition of ground pork products available in the US retail market were needed to update the USDA National Nutrient Database for Standard Reference (SR) and to support nutritional intake studies of the population. A collaborative study was conducted to determine the mathematical relationship between individual nutrients and fat content of raw ground pork using mixed model regression analysis. Sixteen ground pork samples were obtained from each of the four US commercial packers. These samples were formulated by the packer to provide the following fat levels low fat, 1 to 8%; medium fat, 10 to 25%; and high fat, 26 to 30%. Samples from each fat level were divided into aliquots for raw products, grilled patties, and pan-browned crumbles. Patties and crumbles were cooked on a pre-heated electric skillet to an internal temperature of 165º F. After cooling, and draining using a prescribed method, samples were homogenized into individual or composite samples for nutrient analysis. Samples were analyzed for proximates, cholesterol, and B-vitamins using AOAC methods and for mineral content by atomic absorption spectrophotometry. Quality assurance was monitored through the use of certified reference materials, in-house controls, and random duplicate sampling. For, most nutrients, in the raw sample and in cooked crumbles the relationship to raw total fat content was linear. For many lipid-associated nutrients in grilled samples however, the relationship to raw total fat was quadratic. A linear relationship existed between total fat (from 2-30%) and the minerals K, Mg, P and Se. Niacin and thiamin had a positive linear relationship with raw total fat whereas no relationship was noted with riboflavin and total fat. Equations developed during this study are designed to be used by the pork industry to estimate nutrient values for labeling ground pork products. These equations will be disseminated with SR 22.

Introduction

• Ground pork is a combination of lean meat and fat, derived from various pork cuts. It is ground finely or coarsely depending on the amount of fat present. Previous studies indicated that total fat in ground pork products sold in retail stores ranges from 4% to 30%.

• Data on the nutrient composition of representative ground pork products currently available in the US retail market was needed to update the USDA National Nutrient Database for Standard Reference (SR).

•Scientists at USDA (Nutrient Data Laboratory), the National Pork Board and Texas Tech University collaborated to determine the mathematical relationship between the content of individual nutrients and the fat content of raw ground pork using mixed model regression analysis in order to predict nutrient content based on fat content.

Objectives

• Establish the mathematical relationship between the analytical values for various nutrients and the total fat content of raw ground pork using regression techniques.

• Develop regression equations for estimating the nutrient content of retail ground pork for three total fat content levels defined as low fat (2-6%), medium fat (14-18%) and high fat (26-30%).

•Applying the resulting equations to predict the nutrient profiles for ground pork (raw, pan-browned crumbles, and pan-broiled patties) at three fat levels (4%, 16% and 28%).

Methodology

• **Sampling and preparation**: Ground pork samples were obtained from four US commercial packers (Smithfield, Premium Standard Farms, Farmland, and Johnsonville). These samples were specially formulated by the packer to provide the following fat levels; low fat (2 – 6%), medium fat (14-18%) and high fat (26 - 30%). Samples from each fat level were prepared under three conditions: as raw product, pan-broiled patties, and pan-browned crumbles. They were composited within fat levels across packers; according to the sampling plan (Fig 1).

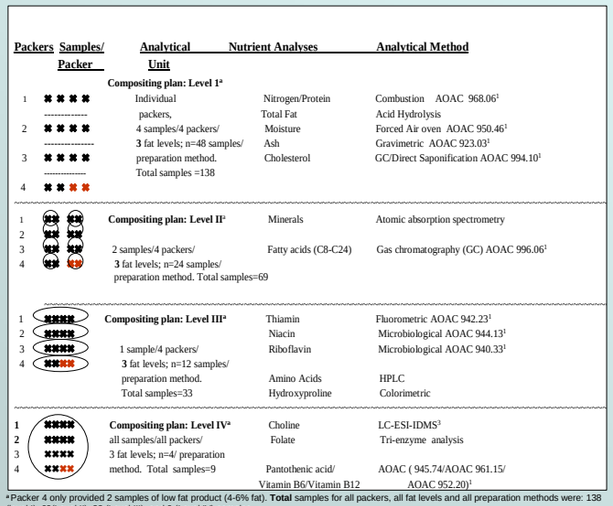
Pan-broiled patties - Approximately 112 g of raw ground pork was weighed and formed into patties. Patties were grilled for 13-15 minutes, on a preheated to 204°C West Bend skillet turning once, Patties were removed from the pan when the internal temperature reached 74°C and allowed to cool for 5 minutes on a rack.

Pan-browned crumbles - Approximately 224g of raw ground pork were weighed and blended into patties. Three to four patties were placed on a pre-heated 204°C West Bend electric skillet and pan-browned for 5 minutes. Patties were broken apart with a silicon turner while browning to form crumbles and removed from the pan when the internal temperature reached 74°C. Crumbles were drained in a colander to remove excess fat. Crumbles were allowed to cool at room temperature for 5 minutes then placed into clean unsealed vacuum bags and stored in the cooler at 3°C.

• **Analytical Methodology:** Valid and accepted methods of the AOAC[1] were used for nutrient analysis as indicated in Fig 1.

• **Analytical Quality Control:** Quality control was monitored through the use of Certified reference materials (NIST 1546), in-house control composites (Beechnut Beef baby food and Beechnut Chicken baby food) and random duplicate sampling.

• **Statistics:** Regression equations were developed for each nutrient in the raw and each of the cooked products relative to fat level using mixed model Regression analyses (SAS,2004)[2]. These equations were then used to estimate nutrient profiles.



[a]Packer 4 only provided 2 samples of low fat product (4-6% fat). **Total** samples for all packers, all fat levels and all preparation methods were: 138 (level I), 69(Level II), 33 (Level III), and 9 (Level IV) samples.

Figure 1. Sampling, compositing, and nutrient analysis plan for ground pork products varying in total fat content and preparation (raw, pan-browned crumbles and pan-broiled patties).

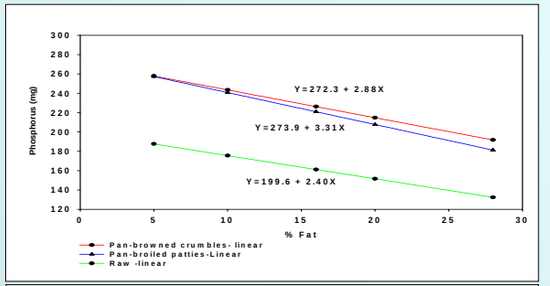


Fig 2. Example of mathematical relationship of phosphorus to the fat content of ground pork . In this example , the relationship is linear for the raw (green line), pan-browned crumbles (red line) and pan-broiled patties (blue line).

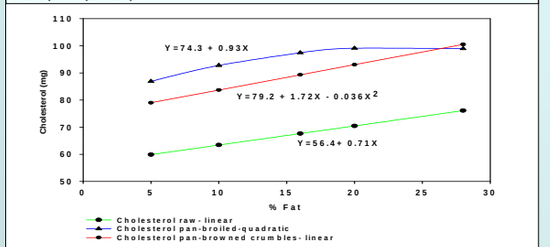


Fig 3. Example of mathematical relationship of a fat soluble dietary component (cholesterol) to the fat content of ground pork. In this example , the relationship is linear for the raw product (green line) and for the pan-browned crumbles (rd line), but quadratic in the pan-broiled patty (blue line).

Table 1. Nutrient content of low fat ground pork (96% lean, 4% fat)

Nutrients	Unit	n[1]	96% lean, 4% fat					
			Raw	S.E.M.	Pan-browned crumbles	S.E.M	Pan-broiled patties	S.E.M
			100g	100g	100g	100g	100g	100g
Water	g	14	73.6	0.3	61.0	2.5	60.1	1.0
Energy	kcal	-	120	-	187	-	183	-
Protein	g	14	21.1	0.2	30.6	1.5	31.7	0.5
Total lipid	g	14	4.0	0.1	7.2	1.3	6.2	1.3
Ash	g	14	1.1	0.0	1.4	0.1	1.5	0.1
Calcium	mg	7	15	0.5	19	0.9	20	1.1
Iron	mg	7	0.9	0.1	1.1	0.1	1.1	0.1
Sodium	mg	7	67	5.8	84	4.5	88	0.9
Vitamin C[2]	mg	-	0	-	0	-	0	-
Vitamin A[2]	IU	-	0	-	0	-	0	-
Vitamin D	mcg	1	4.2	0	7.3	0	6.3	0
Saturated FA	g	7	1.3	0.1	2.0	0.2	2.1	0.1
Total trans FA	g	7	.02	.007	.03	.009	.03	.03
Cholesterol	mg	14	59	2.8	78	4.9	85	5.2
Magnesium	mg	7	19	0.5	27	1.1	25	0.9
Phosphorus	mg	7	190	2.7	261	16.4	261	7.6
Potassium	mg	7	310	6.7	428	15.3	415	25.8
Zinc	mg	7	1.9	0.1	2.6	0.1	2.6	0.2
Selenium	mcg	7	34.8	5.6	46.7	6.6	49.1	7.5
Thiamin	mg	3	0.4	0.1	0.5	0.1	0.4	0.1
Riboflavin	mg	3	0.4	0.0	0.5	0.1	0.4	0.1
Niacin	mg	3	7.9	0.8	11.1	1.0	10.3	0.9
Pantothenic acid	mg	1	0.6	-	0.8	-	0.8	-
Vitamin B_6	mg	1	0.7	-	0.7	-	0.6	-
Vitamin B_{12}	mcg	1	0.6	-	0.9	-	0.8	-

Values represent Least Square Means ± S.E.M.
[1]Only 2 samples were obtained from 1 packer.
[2] Assumed Zero's

Table 2. Nutrient content of medium fat ground pork (84% lean and 16% fat)

Nutrients	Unit	n[1]	84% lean, 16% fat					
			Raw	S.E.M	Pan-browned crumbles	S.E.M	Pan-broiled patties	S.E.M
			100g	100g	100g	100g	100g	100g
Water	g	16	64.7	0.2	51.4	2.5	52.0	0.9
Energy	kcal	-	216	-	287	-	301	-
Protein	g	16	18.0	0.1	26.7	1.5	27.1	0.4
Total lipid	g	16	16		20.0	2.2	21.4	1.2
Ash	g	16	0.9	0.0	1.1	0.1	1.3	0.1
Calcium	mg	8	15	0.3	20	0.6	20	0.7
Iron	mg	8	0.8	0.1	1.1	.03	1.2	0.0
Sodium	mg	8	68	5.2	89	4.1	89	4.3
Vitamin C[2]	mg	-	0	-	0	-	0	-
Vitamin A[2]	IU	-	0	-	0	-	0	-
Vitamin D	mcg	1	16.8	0.0	20.4	0.0	21.8	0.0
Saturated FA	g	8	5.4	0.1	6.6	0.2	7.5	0.2
Total trans FA	g	8	0.1	0.1	0.1	0.1	0.2	0.0
Cholesterol	mg	16	68	2.0	89	3.5	97	4.9
Magnesium	mg	8	16	0.3	23	1.0	22	0.6
Phosphorus	mg	8	161	2.3	226	14.8	221	6.3
Potassium	mg	8	244	5.3	354	14.7	345	24.0
Zinc	mg	8	1.9	0.1	2.6	0.1	2.5	0.2
Selenium	mcg	8	30.2	5.4	42.4	6.3	43.5	7.2
Thiamin	mg	4	0.3	0.1	0.4	0.1	0.4	0.1
Riboflavin	mg	4	0.3	0.1	0.5	0.1	0.5	0.0
Niacin	mg	4	6.4	0.6	9.3	0.8	8.6	0.8
Pantothenic acid	mg	1	0.6	-	0.9	-	0.8	-
Vitamin B_6	mg	1	0.6	-	0.6	-	0.5	-
Vitamin B_{12}	mcg	1	0.7	-	1.0	-	1.0	-

Values represent Least Square Means Values represent ± S.E.M.
[1]Four samples per packer.
[2] Assumed Zero's

Table 3. Nutrient content of high fat ground pork (72 % lean, 28% fat)

Nutrients	Unit	n[1]	72% lean, 28% fat					
			Raw	S.E.M	Pan-browned crumbles	S.E.M	Pan-broiled patties	S.E.M
			100g	100g	100g	100g	100g	100g
Water	g	16	55.7	0.3	41.7	2.6	43.9	1.0
Energy	kcal	-	311	-	388	-	373	-
Protein	g	16	14.9	0.2	22.8	1.5	22.6	0.5
Total lipid	g	16	28		32.9	4.1	31.4	1.3
Ash	g	16	0.8	0.0	1.2	.08	1.1	0.1
Calcium	mg	8	16	0.4	20	0.7	20	1.0
Iron	mg	8	0.9	0.1	1.2	0.1	1.2	0.1
Sodium	mg	8	69	5.7	94	4.5	91	4.7
Vitamin C[2]	mg	-	0	-	0	-	0	-
Vitamin A[2]	IU	-	0	-	0	-	0	-
Vitamin D	mcg	1	29.4	-	33.5	-	32.0	-
Saturated FA	g	8	9.4	0.0	11.3	0.3	10.8	0.3
Total trans FA	g	8	0.2	0.0	0.3	0.1	0.2	0.1
Cholesterol	mg	16	76	2.7	100	4.8	99	4.9
Magnesium	mg	8	13	0.3	19	1.1	18	0.7
Phosphorus	mg	8	132	3.1	192	16.3	181	7.6
Potassium	mg	8	178	8.9	280	19.2	275	25.6
Zinc	mg	8	1.9	0.1	2.6	0.1	2.5	0.2
Selenium	mcg	8	25.6	5.5	38.0	6.2	37.9	7.3
Thiamin	mg	4	0.3	0.1	0.3	0.1	0.3	0.1
Riboflavin	mg	4	0.3	0.1	0.5	0.1	0.5	0.1
Niacin	mg	4	4.9	0.7	7.5	0.9	6.9	0.9
Pantothenic acid	mg	1	0.6	-	1.0	-	0.8	-
Vitamin B_6	mg	1	0.4	-	0.5	-	0.4	-
Vitamin B_{12}	mcg	1	0.8	-	1.2	-	1.1	-

Values represent Least Square Means ± S.E.M.
[1]Four samples per packer
[2]Assumed Zero's

Results

• The mathematical relationship between various nutrients and total fat was developed for ground pork varying in total fat content 4 - 28% fat using regression techniques.

• In the raw samples the relationship between all nutrients and total fat content was linear. (Figures 2 and 3).

• The relationship between minerals and total fat content of pan-browned samples was linear. However, for pan-broiled samples, the relationship between the lipid-soluble nutrients, cholesterol and fatty acids, the relationship with total fat was quadratic (Fig 3).

• Nutrient profiles for raw, pan – browned crumbles and pan-broiled patties for all three fat ranges were derived from these equations. (Table 1, 2 and 3).

Summary

• The equations developed during this study are designed to be used by the meat industry to estimate nutrient values for labeling ground pork products.

• Nutrient profiles for ground pork products containing approximately 4%, 16% and 28% fat will be released in SR 22 http://www.ars.usda.gov.

• These data will be used in nutrition monitoring, establishment of national nutrition policy, health research, food product development and to assist industry vendors for in developing labels to meet the proposed new labeling regulations for single nutrient pork products.

Discussion

• The relationship between nutrients and total fat in ground pork appears to be affected by the cooking method.

• The results of this study provide a mechanism by which the nutrient content of ground pork can be estimated for any product formulated with a fat content ranging from 4% to 28%.

References

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