EFFECTS OF DIETARY FAT AND VITAMIN E UPON THE STABILITY OF MEAT IN FROZEN STORAGE

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Sixteen 4-day old veal calves were allotted into four groups and fed solely on filled milk in which half the calves received a stable saturated fat (coconut oil) and the other half an unsaturated fat (corn oil). Half of the calves on each fat treatment were supplemented with 500 mg d-α-tocopheryl acetate per calf per day, whereas, the remainder were unsupplemented. The calves were slaughtered after 8 weeks and samples of omental and kidney fat and of meat (longissimus dorsi muscle) were removed, wrapped in freezer paper and stored at -18°C. The initial samples were analyzed for fatty acid composition. Samples were also analyzed at 0, 1, 3, and 6 months storage for vitamin E and TBA values.

Coconut oil markedly increased the levels of lauric and myristic acids as well as the level of saturated fatty acids in the depot and tissue lipids, whereas, corn oil increased the level of polyunsaturated fatty acids (PUFAS), especially the level of linoleic acid in both the depot fats and the phospholipids. Inclusion of vitamin E in the diet resulted in an elevated level in the depot fats, but had less influence upon the meat lipids. By 6 months storage, the TBA values had increased to the threshold level for rancidity in the kidney fat, but were well below threshold levels in the omental fat and meat. Vitamin E declined steadily during freezer storage, the decline being most marked in the kidney fat and the meat lipids. Results indicate that dietary vitamin E and saturated fatty acids contribute to meat stability during frozen storage.

EFFETS DE LA GRAISSE ALIMENTAIRE ET DE LA VITAMINE E SUR LA STABILITÉ DES VIANDES CONSERVÉES EN FRIGORIFIQUE

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Seize veaux nouveaux-nés de 4 jours ont été répartis en quatre groupes et nourris exclusivement de lait additionné, auquel pour la moitié de ces veaux était ajoutée une graisse saturée stable (huile de noix de coco) et pour l'autre moitié une graisse non saturée (huile de maïs). La moitié des veaux de chaque groupe de traitement en graisse recevaient en outre 500 mg d'acétate de tocophérol d-α par tête et par jour, alors que les autres ne recevaient aucun supplément. Ces veaux ayant été abattus au bout de 8 semaines, il a été opéré sur eux des prélèvements de graisse omentale et rénale et de viande (muscle dorsal longitudinal), qui ont été enveloppés dans du papier à congélateur et emmagasinés à -18°C. Les prélèvements originaires ont été analysés pour le teneur en acides gras. Il a également été procédé à l'analyse de prélèvements après 0, 1, 3 et 6 mois d'emmagasinage en vue de déterminer leur teneur en vitamine E et en A.T.B.

L'huile de noix de coco a entraîné une augmentation notable des teneurs en acide laurique et en acide myristique de même que dans acides gras saturés dans les lipides du dépôt et du tissu, alors que l'huile de maïs entraînait un accroissement de la teneur en acides gras non saturés, en particulier celle en acide linoléique, à la fois dans les graisses du dépôt et dans les phospholipides. L'adjonction de vitamines E au régime alimentaire a entraîné un taux élevé des graisses de dépôt mais n'a exercé qu'une faible influence sur les lipides de la viande. Au bout de six mois d'emmagasinage, les taux en A.T.B. s'étaient accrus jusqu'aux niveaux de seuil pour la rancidité de la graisse rénale mais restaient nettement au-dessous de ces niveaux dans la graisse omentale et dans la viande. La teneur en vitamine E a diminué de facon continue pendant la période d'emmagasinage frigorifique, cette diminution étant surtout marguée dans la graisse rénale et dans les lipides de la viande. Ces résultats montrent que la vitamine alimentaire E et les acides gras saturés contribuent à la stabilité de la viande pendant la période d'emmagasinage frigorifique.

(Traduction faite par les soins du Centre Suédois de recherche sur les viandes)

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DIE WIRKUNG VON SPEISEFETT UND VITAMIN E AUF DIE HALTBARKEIT VON FLEISCH BEI TIEFKÜHLLAGERUNG

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Sechzehn 4 Tage alte Fleischkälber wurden in vier Gruppen eingeteilt und ausschliesslich mit präparierter Milch ernährt, wobei die eine Hälfte der Kälber konstant gesättigtes Fett (Kokosöl) und die andere Hälfte ungesättigtes Fett (Maisöl) erhielt. Die Hälfte der Kälber erhielt bei jeder Fettbehandlung als Ergänzung 500 mg d-∝-tocopheryl acetat pro Kalb und Tag, während der Rest keine Zusatznahrung erhielt. Die Kälber wurden nach 8 Wochen geschlachtet, und Proben von Darm- und Nierenfett sowie von Fleisch (Longissimus dorsi-Muskel) wurden entnommen, in Tiefkühlpapier eingeschlagen und bei -18°C gelagert. Die ursprünglichen Probestücke wurden auf die Fettsäurenzusammensetzung hin untersucht. Die Proben wurden auch nach einer Lagerungszeit von 0, 1, 3 und 6 Monaten auf E-Vitamin und TBA-Werte analysiert.

Kokosöl erhöhte merkbar den Spiegel von Laurinsäure und Myristinsäure sowie den Spiegel gesättigter Fettsäuren, sowohl in den Depot- wie in den Gewebelipiden, während Maisöl den Spiegel von mehrfach ungesättigten Fettsäuren (PUFAS) erhöhte, insbesonders den Spiegel von Linolsäure, sowohl in den Depotfetten wie in den Phospholipiden. Die Einbeziehung von Vitamin E in die Kost führte zu einem höheren Spiegel in den Depotfetten, hatte jedoch einen geringeren Einfluss auf die Fleischlipiden. Nach 6 Monaten Lagerung hatten sich die TBA-Werte auf einen an Ranzigkeit grenzenden Spiegel im Nierenfett erhöht, lagen jedoch ein gutes Stück unter den Grenzwerten im Darmfett und im Fleisch. Das Vitamin E nahm während der Tiefkühllagerung stetig ab, wobei die Abnahme am deutlichsten im Nierenfett und in den Fleischlipiden hervortrat. Die Ergebnisse lassen erkennen, dass eine Kostbeigabe von Vitamin E und gesättigten Fettsäuren zur Haltbarkeit von Fleisch bei Tiefkühllagerung beiträgt.

/Übersetzung durch Vermittlung des Fleischforschungsinstituts/

ВЛИЯНИЕ ДИЭТИЧЕСКОГО ЖИРА И ВИТАМИНА Е НА СТАБИЛЬНОСТЬ МЯСА ПРИ ХРАНЕНИИ В ЗАМОРОЖЕННОМ СОСТОЯНИИ

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Шестнадцать 4-дневных молочных телят были выделены в четыре группы. Телят кормили только обезжиренным молоком с наполнителями. Причем, для половины телят в группах наполнителем в молоке являлся стабильный насыщенный жир (кокосовое масло), а для другой половины наполнителем являлся ненасыщенный жир (кукурузное масло). Половине телят к каждой порции жира добавлялся d-токоферил ацетат в количестве 500 мг в день на теленка, а половина такой добавки к корму не получала. Телята были забиты через 8 недель. Отобранные пробы рубашечного и почечного жира и мяса (мускулы (longissimus dorsi) были завернуты в бумагу для замороженных продуктов и хранились при температре -18°С. В исходных пробах определялся состав кислоты жирного ряда. Пробы также подвергались анализу с целью определения значений витамина Е и ТВА (тиобарбитуровая кислота).

Кокосовое масло заметно увеличило уровни лауриновой и миристиновой кислот жирного ряда в отложениях липоида и в тканевом липоиде, в то время как кукурузное масло повысило уровень полиненасыщенных кислот жирного ряда (PUFAS) и, особенно, уровень линолевой кислоты как в жировых отложениях, так и в фосфатидах. Включение в диету витамина Е вызвало увеличение уровня жировых отложений, но оказало меньше влияния на липоид мяса. При 6-месячном хранении значение ТВА (тиобарбитуровая кислота) увеличилось до порогового уровня прогорклости в почечном жире, но было значительно ниже пороговых уровней в рубашечном жире и в мясе. При хранении в замороженном состоянии наблюдалось постоянное убывание витамина Е, причем это было наиболее заметно в почечном жире и липоиде мяса. Результаты показали, что диэтический витамин Е и насыщенные кислоты жирного ряда способствуют стабильности мяса при хранении в замороженном состоянии.

(Перевод выполнен при содействии научно-исследовательского мясного института)

EFFECTS OF DIETARY FAT AND VITAMIN E UPON THE STABILITY OF MEAT IN FROZEN STORAGE

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Design of Study

Sixteen 4-day old veal calves were allotted into four groups and fed entirely on filled milk in which half of the calves received a stable saturated fat (coconut oil) and the other half an unsaturated fat (corn oil). Half of the calves on each diet were supplemented with 500 mg d-α-tocopheryl acetate per calf per day. The calves were slaughtered after 8 weeks and samples of kidney and omental fat and of meat (longissimus dorsi muscle) were removed, wrapped in freezer paper, frozen and stored at -18°C. Initial samples were analyzed for fatty acid composition by GLC (gas liquid chromatography), whereas, samples were analyzed for vitamin E and TBA numbers following 0, 1, 3 and 6 months freezer storage.

Experimental Objectives

This study was designed to determine the effects of the fatty acid composition of the diet upon the composition of the depot fats (omental and perinephric) and the meat (triglycerides and phospholipids). In addition, the effects of vitamin E supplementation and the composition of the lipids upon the stability of the depot fats and meat lipids during freezer storage (-18°C) were followed by TBA analysis and the disappearance of vitamin E.

Results and Discussion

Slaughter Data

Average slaughter weights varied from 139 lbs. for group 3 (corn oil plus vitamin E) to 162 lbs. for group 1 (coconut oil plus vitamin E). There was great variability in liveweight, and hence, in carcass weights and yields. Carcass yields were 63.03, 58.60, 53.30 and 61.13% for groups 1 through 4, respectively. Group 3 was significantly lower ($P > .05$) in both liveweight and dressing percent than all other groups.

Fat Content of Tissues

The amount of fat in the L.D. muscle was on average 1.66, 1.44, 1.76 and 1.45% for groups 1, 2, 3 and 4, respectively, while the corresponding phospholipid content was 0.84, 0.76, 0.75 and 0.82%. There was considerable variation in fat content of the kidney depots with values of 74.47, 66.08, 23.60 and 73.18% for groups 1, 2, 3 and 4 respectively. Corresponding values for the fat content of the omental depots were 69.55, 68.33, 27.28 and 44.23%.

Fatty Acid Composition of Triglycerides

The fatty acid composition of the kidney fat and omental fat from the calves on the different treatments is shown in Table 1. The same data for the fatty acid composition of the triglycerides from the L.D. muscle are also given by groups in Table 1. The level of C18:2 (linoleic) acid was essentially the same for the kidney, omental and meat triglycerides for groups 3 and 4 (corn oil) and varied from approximately 26 to 30% of the total fatty acids. Although groups 1 and 2 (coconut oil) also contained similar amounts of C18:2 fatty acids in the kidney, omental and meat triglycerides, the level ranged from only 4 to 8%. Thus, the two diets markedly influenced the linoleic acid content of the depot fats. On the other hand, vitamin E supplementation had only a slight influence on the C18:2 content of the depots.

The level of oleic (C18:1) acid was about 30% for the depot fats of calves on corn oil diets and approximately 23% for the coconut oil treatments. The amount of palmitic (C16:0) acid was approximately 30% in the depot fats of calves fed coconut oil diets as compared to 20% for those from the corn oil rations. Stearic (C18:0) acid was essentially the same (about 10%) for both the corn oil and coconut oil diets.

The high level of lauric (C12:0) acid in the coconut oil was not closely reflected by its level in the depot fats from calves fed this diet, although it ranged from approximately 5 to 8% in the depots of the calves fed coconut oil as compared to a range of only about 0.6 to 1.2% for the corn oil fed animals. The level of myristic (C14:0) acid in the depot fats and meat triglycerides of the calves fed coconut oil was greatly increased (18 to 23%) as compared to those fed corn oil (5 to 7%). However, vitamin E supplementation of the coconut oil diet appeared to cause a decrease in the amounts of lauric and myristic acid in the depot and meat triglycerides.

Table 2 shows that the coconut oil diet greatly increased the proportion of saturated fatty acids in the depot fats, whereas, the corn oil diet increased the proportion of unsaturated fatty acids in the depots. Therefore, the diet greatly altered the composition of the fatty acids in the depot fats, reflecting the fatty acid profile of the ration.

Phospholipids in the Meat

Table 2 shows the effects of diet upon the fatty acid profile of the phospholipids from the meat. There were only small differences in the level of total saturated fatty acids in the phospholipids from the meat of animals on the two diets. However, there were rather large differences between the monoenoic and dienoic acids from the phospholipids of meat from calves fed the corn oil and coconut oil rations. On the other hand, the total unsaturated fatty acids were approximately the same except for those from group 1 (coconut oil plus vitamin E).

Stability of Vitamin E during Freezer Storage

Vitamin E supplementation increased the levels in all tissues, but the increase was much less than expected in view of the level of feeding. There was a steady decline in the level of tocopherol in all tissues as the length in freezer storage increased. However, the rate of loss was much greater in the kidney fat than from the omental fat or meat.

Although the initial levels of tocopherol were essentially the same in the kidney and omental fat, the faster disappearance of vitamin E from kidney fat suggests more rapid turnover in the kidney depots. Similarly, tocopherol levels in the tissues from calves fed coconut oil supplement with vitamin E declined at a more rapid rate during storage than those from calves fed corn oil, even though the initial levels of vitamin E were higher for the coconut oil supplemented calves.

Oxidation as Measured by TBA Values

Results showed that both the meat and omental fat were stable up to 6 months of storage with TBA values below 0.3. There was, however, a steady increase in TBA numbers as the storage period was increased. The rate of oxidation was more rapid in kidney fat than in omental fat or the meat, which provides further support for the idea that the kidney fat has a more rapid turnover than the other tissues. It is interesting to note that the threshold level of about 1.5 was reached by group 4 (corn oil, no vitamin E) by 6 months storage.

Summary

Results showed that young veal calves selectively deposit dietary fat in the tissues without significantly altering the fatty acid profile. Coconut oil markedly increased the levels of myristic and palmitic acids as well as the level of saturated fatty acids in the depot fats, whereas, corn oil markedly decreased the levels of myristic and palmitic acids and increased the level of polyunsaturated fatty acids, especially of linoleic acid. Supplementation of coconut oil diets with vitamin E significantly elevated its level in the depot fats but had little effect upon the meat lipids. Vitamin E supplementation of corn oil rations did not significantly improve the level retained by the depot fats or meat lipids.

Vitamin E declined steadily during freezer storage, however, the rate of decline was much faster in kidney fat than in meat lipids or the omental fat. TBA values for kidney fat from the calves fed corn oil without supplemental vitamin E had reached threshold levels by 6 months freezer storage. All other values were below the threshold levels, which indicated that feeding of saturated fat and vitamin E supplementation contributed to meat stability during frozen storage.

Table 1. Fatty acid composition of the kidney and omental fats and of the triglycerides of the meat as influenced by diet (% of total).

Diets	1	2	3	4
Fatty acid	Coconut oil + vitamin E	Coconut oil, no vitamin E	Corn oil + vitamin E	Corn oil, no vitamin E
		Kidney Fat		
C12:0	5.26	7.41	1.18	1.15
C14:0	19.21	24.58	5.91	5.72
C14:1	1.02	0.96	0.00	0.15
C16:0	30.54	29.43	18.95	19.69
C16:1	1.72	1.76	1.75	1.88
C18:0	11.48	8.93	13.59	11.48
C18:1	23.71	22.03	32.84	30.88
C18:2	7.00	4.90	25.77	29.05
		Omental Fat		
C12:0	5.92	8.38	0.95	1.29
C14:0	23.19	23.38	5.23	7.16
C14:1	1.20	1.48	0.17	0.64
C16:0	31.09	31.06	20.41	23.63
C16:1	1.35	2.26	1.26	1.84
C18:0	9.93	8.47	12.76	8.90
C18:1	21.22	20.14	30.65	29.49
C18:2	6.08	4.44	28.57	26.95
		Glycerides of L.D. Muscle		
C10:0	0.00	0.29	1.63	0.81
C12:0	4.68	6.03	0.59	0.99
C14:0	18.65	22.69	5.66	5.76
C14:1	1.89	1.64	0.15	0.45
C15:0	0.00	0.00	2.15	1.94
C16:0	28.49	28.39	16.69	17.29
C16:1	2.49	2.88	1.57	2.93
C18:0	9.30	8.09	10.33	10.25
C18:1	26.30	23.71	30.79	30.62
C18:2	8.00	6.28	29.99	26.94
C18:3	0.00	0.00	0.00	0.53

Table 2. Effects of diet upon the percentage of saturated, monoenoic, dienoic and polyenoic fatty acids in the kidney and omental fats and in the meat triglycerides and phospholipids (% of total).

Diets	1	2	3	4
Type Fatty Acid	Coconut oil + vitamin E	Coconut oil, no vitamin E	Corn oil + vitamin E	Corn oil, no vitamin E
		Kidney Fat		
% saturated	66.5	70.4	39.6	38.0
% monoenoic	26.5	24.8	34.6	32.9
% dienoic	7.0	4.9	25.8	29.1
% polyenoic	0.0	0.0	0.0	0.0
		Omental Fat		
% saturated	70.0	71.7	39.4	33.8
% monoenoic	23.8	23.9	23.1	32.0
% dienoic	6.1	4.4	28.6	27.0
% polyenoic	0.0	0.0	0.0	0.0
		L. D. Triglycerides		
% saturated	61.1	65.5	37.1	37.0
% monoenoic	30.7	28.0	32.5	27.0
% dienoic	8.0	6.3	30.0	27.0
% polyenoic	0.0	0.0	0.0	0.0
		Meat Phospholipids (L.D.)		
% saturated	36.8	35.5	31.3	33.2
% monoenoic	25.2	31.9	14.5	17.0
% dienoic	26.2	27.3	44.2	41.0
% polyenoic	11.7	9.3	9.9	9.9