EFFECT OF PROLONGED FREEZE STORAGE AT -20°C ON MOISTURE LIPID RELATIONSHIP IN SEVEN EGYPTIAN BEEF, BUFFALO AND MUTTON BY-PRODUCTS

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SUMMARY: This investigation was carried out on seven Egyptian beef, buffalo and mutton by-products namely: liver, heart, kidney, spleen, brain, lung and tongue in an attempt to find out new specified equations indicating the relationship between moisture and lipid contents in such organs. Likewise the effect of prolonged freeze storage at -20°C on moisture lipid relationship in these beef, buffalo and mutton by products was assessed as well.

Both moisture and lipid contents were determined as outlined in the official methods of analysis of A.O.A.C.

The data revealed that the correlation coefficient between moisture and lipid contents was negative. It was found that correlation coefficient was highest for mutton (r= -0.633), medium for beef (r= -0.606) and least for buffalo (r= -0.533).

Besides, it has been found that such relationship for heart, kidney, spleen, lung and tongue for all studied organs for beef, buffalo and mutton was as follows:

Beef	L = 78.99-0.17M
Buffalo	L = 93.13-0.24M
Mutton	L = 99.91-0.24M

On the other hand, liver and brain gave the following specified equations for beef, buffalo and mutton:

Beef	Liver	L = 21.70-0.05M
	brain	L = 41.50-0.007M
Buffalo	Liver	L = 36.47-0.12M
	brain	L = 38.09-0.01M
Mutton	Liver	L = 43.48-0.12M
	brain	L = 60.01-0.04M

INTRODUCTION: The body organs can be classified into two groups: those which are composed of muscle (e.g., the heart) or partially composed of muscle (e.g. the lung), and those which do not contain muscle (e.g., the liver, kidney and pancreas).

Wright and Forsyth (1927), Lushbough and Schweigert (1960), Sokolof (1960), Gristsai (1961) and Karan-Durdic (1976) reported an over all summary of average values for moisture content and total lipid of edible portion of fresh meat organs.

Data indicated that the fresh tongue and liver for the three studied animals contained rather lower moisture content than the other studied organs. Meanwhile, the brain and lung for beef, buffalo and mutton recorded the higher content of the moisture than the other studied organs Likewise, table (1) indicated that a definite remarkable significant drop in the moisture content of all studied organs took place during storage. The decrement in moisture content might be due to evaporation losses during frozen storage and drip from the thawed frozen meat (Harris and Van Loesceke, 1960).

Such results are in agreement with those reported by Wright and Forsyth (1927), Lushbough and Schweigert (1960), Sokolof et al. (1960) and Gristsai et al. (1961).

Lipid content

The results of the influence of freezing and 6 months storage at -20°C on the lipid content of liver, heart, kidney, spleen, brain, lung and tongue of beef, buffalo and mutton are tabulated in table (3). Such data were further analysed statistically and results are presented in table (4). The results revealed that there was an increase in the lipid content during the freeze storage period in all studied samples. The increase of lipid might be due to drip losses, because lipid content dependent upon drip losses during storage when moisture content was decreased the lipid content was increased (Polymenidis, 1975).

Such results are in agreement with those previously reported by Wright and Forsyth (1927), Lushbough and Schweigert (1960), Sokolof, (1960), Gritsai (1961), Kiernat (1964).

Moisture-lipid relationship:

The effect of freezing and six months storage at -20°C for all the seven studied organs for beef, buffalo and mutton on moisture and lipid contents were studied and their relationship was reported as equations. Such equations indicated that there is a relationship between the moisture and lipid content for all organs studied within each animals.

The results revealed that the correlation coefficient between moisture and lipid contents was negative. Such finding means that the relationship between both of them was reversible (i.e.), as the former was increased the latter was decreased. It has been found that such correlation coefficient was highest for mutton ($r= -0.633$), medium for beef ($r= -0.606$) and least for buffalo ($r= -0.533$).

Besides, it has been found that such relationship for heart, kidney, spleen, lung and tongue for all studied animals is related to one equation. These five organs were spotted on a curve indicating the relationship between moisture and lipid percentage. These equations were the following

Boguciki and Trzesivski (1950) and Kordyl (1951) demonstrated that there was a relationship between water content and the amount of the fat. Brands and Dietrich (1953) had found that there was a close relationship between fat content and water content in herring independent of season, degree of maturity and fishing ground. Brandes (1954) demonstrated that there was storage negative correlation between the amount of fat and that of water in animal tissue Harris and Vanloesecke (1960) reported that the decrease of water might be due to evaporation losses during frozen storage and to drip from the thawed frozed meats. Borgstrom (1961) recommended the usage of such correlation calculations, regression lines the so-called FW (fat, water) lines for commercial purposes as a kind of nomogram. Consequently only a reliable water analysis is required and from that value that fat content may be derived, with higher degree of accuracy. Changes in meat during freezing are discussed by Polymenidis (1975), drip losses and increased in lipid.

There is very few, if any, available information about meat organs in recent litrature i.e., Malyshko (1986) and Langlands et al., (1987). However, even these investigations dealt with technology for manufacture of a paste from meat by-products using milk proteins and the mineral composition of such organs. Therefore, it deemed of value to carry out this investigation to find out specified equations indicating the relationship between moisture and lipid contents in seven Egyptian beef, buffalo and mutton organs, as well as the effect of prolonged freeze storage at -20°C on moisture-lipid relationship in such organs.

MATERIALS AND METHODS: Three samples of each of seven meat organs namely: liver, heart, kidney, spleen, brain, lung and tongue withdrawn from the various sources of meat animals, i.e. (beef, buffalo and mutton) were obtained immediately after slaughtering from the local market. Samples packed in polyethylene bags, frozen at -20°C, and were further stored at -20°C for 2, 4 and 6 months. By the end of every freezing period samples were drawn at random, thawed at room temperature and then analysed. Moisture and lipid content were determined according to the methods described by A.O.A.C. (1960) and Folch et al. (1957), respectively.

Data were statistically analysed according to the method described by Snedecor (1962).

RESULTS AND DISCUSSION:

Moisture content:

Results of the influence of freezing and 6 months storage at -20°C on the percentage of moisture content of liver, heart, kidney, spleen, brain, lung and tongue of beef, buffalo and mutton are tabulated in table (1) such data were further analysed statistically and results are presented in table (2).

for heart, kidney, spleen, lung and tongue for beef, bufallo, and mutton was as follows:

Beef L = 73.99-0.17M
Buffalo L = 93.13-0.24M
Mutton L = 99.91-0.24M

(where L = Lipid content and M = Moisture content) specificed equations for beef, buffalo and mutton organs are as follows:

Beef	liver	L = 21.70-0.05M
	brain	L = 41.50-0.007M
Buffalo	liver	L = 36.47-0.12M
	brain	L = 38.09-0.01M
Mutton	liver	L = 43.48-0.12M
	brain	L = 60.01-0.04M

The negative correlation between the amount of fat and that of water was previously reported by Borgstran (1961).

Such results are in agreement with those reported by Boguciki and Trzesivski (1950), Kordyl (1950), Polymenidis (1975) and Skenderovic (1978).

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Table (1): Effect of prolonged freeze storage at (-20°C) on the percentage of moisture content in beef, buffalo and mutton organs.

Frozen storage period (months)	Liver			Heart			Kidny			Spleen			Brain			Lung			Tongue		
	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton
0	68.78	69.53	71.79	77.00	75.94	73.75	74.66	76.74	78.31	78.33	77.49	77.93	78.87	80.08	79.99	78.37	77.62	80.12	65.68	67.18	69.39
2	67.53	68.97	71.16	76.14	74.95	72.91	73.54	75.83	77.92	77.24	76.90	77.21	77.62	79.34	79.51	77.65	76.80	79.53	64.63	66.81	68.79
4	67.12	68.46	70.62	75.23	73.97	72.05	72.56	74.53	77.52	76.78	76.09	76.49	77.26	78.70	78.93	76.79	75.98	79.13	63.96	66.70	68.06
6	66.91	67.84	70.05	74.95	73.15	71.69	71.72	73.87	76.98	75.95	75.43	75.86	77.01	77.98	78.26	76.45	75.73	78.91	63.62	66.46	67.42

Table (3): Effect of prolonged freeze storage at (-20°C) on the percentage of lipid content in beef, buffalo and mutton organs (on dry weight basis).

Frozen storage period (months)	Liver			Heart			Kidny			Spleen			Brain			Lung			Tongue		
	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton	Beef	Buffalo	Mutton
0	10.49	9.08	12.94	17.08	17.38	33.24	23.90	13.95	13.26	12.54	10.51	15.17	38.90	34.07	44.02	12.39	9.89	3.18	41.46	44.00	45.50
2	11.30	9.79	13.88	19.44	21.32	35.32	26.74	17.83	15.21	16.30	13.23	18.60	39.08	34.25	44.49	14.93	13.68	6.66	42.93	44.81	47.01
4	11.49	10.42	14.64	22.36	24.93	38.04	29.04	22.90	17.15	17.78	16.75	21.82	39.13	34.39	45.03	17.75	17.21	8.91	43.82	45.06	48.77
6	11.59	11.16	15.41	23.13	27.79	39.13	30.88	25.28	19.65	20.30	14.45	24.49	39.16	34.55	45.61	18.80	18.24	10.11	44.26	45.57	50.24

Table (2): Analysis of variance of data given in table (1).

S.V.	D.f	S.S.	M.S	F
Between organs (A)	6	4448.1	741.35	12781.9**
Between kind of animal (B)	2	114.15	57.08	98.4**
Between storage periods (C)	3	123.93	41.31	71.22**
A x B	12	307.47	25.62	44.17**
A x C	18	6.51	0.34	0059
B x C	6	5.13	0.86	1.48
error	204	11.85	0.058	
Total	251			

Table (4): Analysis of variance of data given in table (3).

S.V.	D.f	S.S.	M.S	F
Between organs (A)	6	3419.13	564.86	1899.3**
Between kind of animals (B)	2	9.99	4.99	16.3**
Between storage periods (C)	3	75.42	25.14	83.8**
A x B	12	247.98	20.67	68.9**
A x C	18	11.79	0.66	2.17
B x C	6	1.23	0.21	0.70
error	204	6.3	0.30	
Total	251			

EFFECT OF PROLONGED FREEZE STORAGE AT -20°C ON PHOSPHORUS FRACTIONS IN SEVEN EGYPTIAN BEEF, BUFFALO AND MUTTON BY-PRODUCTS.

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SUMMARY: This investigation was carried out on seven Egyptian beef, buffalo and mutton by-products namely: liver, heart, kidney, spleen, brain, lung and tongue in an attempt to determine phosphorus fractions in these organs. Likewise, the effect of prolonged freeze storage at -20°C and total phosphorus, acidic phosphorus, inorganic phosphorus, lipo-phosphorus, protein phosphorus and acidic organic phosphorus in these beef, buffalo and mutton by-products was assessed as well. Phosphorus fractions were determined applying official methods as outlined in the official methods of analysis of A.O.A.C. The data revealed that the total phosphorus of beef organs were higher than that of buffalo, except kidney. Moreover, buffalo organs were higher in total phosphorus content than that of mutton organs, except liver, tongue and lung. On the other hand, the beef organs contained more acidic phosphorus and acidic organic phosphorus than buffalo and mutton organs, except liver, lung and brain of buffalo which contained more content of acidic organic phosphorus. Inorganic phosphorus content was higher in buffalo organs than that of beef organs, except heart and lung. Moreover, total phosphorus, protein phosphorus and acidic organic phosphorus contents decreased gradually after freezing and storage period. Inorganic phosphorus and acidic phosphorus increased after freezing and during storage period.

INTRODUCTION: Meat by-products consist of any non rendered, clean, whole some parts of the carcass of slaughtered mammals other than meat, such as lung, spleen, liver, kidney, brain, stomach and intestine free from their contents; it does not include skin, horns, teeth, hoofs and bones (Price, 1970). Meat by-products is an excellent source of a wide variety of nutrients namely, high quality protein, vitamins especially the B-complex and of certain minerals (AMIF, 1960). Edible offals (variety meats or meat organs) such as brain, kidney, liver, lung and spleen are among meat by-products and can be considered as a nutritionally rich meal as they contain sufficient amount of high quality animal protein, minerals and vitamins. Moreover, they are easily digested and their extract provokes the flow of gastric juice (El-Moudy, 1979). Wright and Forsyth (1927), Watt and Merrill (1950). Schweigert and payne (1956) reported an over all summary of average values for total phosphorus of edible portion of fresh meat organs. Ferdman (1935) devided the phosphorus to its different constituents namely inorganic, acidic, protein and lipid phosphorus in animal tissues.

Table (2): Analysis of variance of data given in table (1).

S.V.	D.f	S.S.	M.S	F
Between organs (A)	6	4448.1	741.35	12781.9**
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Between storage periods (C)	3	123.93	41.31	71.22**
A x B	12	307.47	25.62	44.17**
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Nagy (1935) classified the phosphorus of fresh beef and pork products as inorganic, phosphagenic and acid soluble. Motoc and Benu (1968) demonstrated that the inorganic phosphorus increased in muscles during freezing. Price (1970) reported that the values for phosphorus are generally higher in the fresh meat organs such as liver, kidney and spleen than they are in fresh muscle and found that freezing and thawing of meat caused some losses of fluid (drip loss)and this fluid will contain a small portion minerals (P, K and Ca). According to John (1975) the total phosphorus in meat decreased during freezing and thawing through drip losses. This investigation was carried out in an attempt to assess the effect of prolonged freeze storage at -20°C on various phosphorus fractions in seven Egyptian beef, buffalo and mutton by-products.

MATERIALS AND METHODS: Three samples of each of seven meat organs namely: liver, heart, kidney, spleen, brain, lung and tongue withdrawn from the various sources of meat animals i.e. (beef, buffalo and mutton) were obtained immediately after slaughtering from the local market. Samples were paked in polyethylene bags, frozen at -20°C, and were further stored at -20°C for 2, 4 and 6 months. By the end of every freezing period samples were drawn at random, thawed at room temperature and then analysed. The total phosphorus and lipophosphorus were determined colormetrically by the sulphomolybdic acid method as described by Jackson (1958) using a spekol colorimeter and a wave length of 660 mμ. The acid soluble phosphorus and inorganic phosphorus were determined colorimetrically according to the method described by Krelova and Laskovskaie (1965). Meanwhile, the protein phosphorus was calculated by difference using the following equation, protein phosphorus: total phosphorus-(lipophosphorus + total acid phosphorus). On the other hand, the organic acid phosphorus was calculated by difference between total acidic and inorganic content. Data were statistically analysed according the method described by Snedecor (1962).

RESULTS AND DISCUSSION: I. Fresh organs: The phosphorus constituents of seven organs of beef, buffalo and mutton are tabulated in table (1). An over look on this table indicated that the total phosphorus of beef organs were higher than that of buffalo, except kidney. Moreover, buffalo organs were higher than that of mutton organs except, liver, tongue and lung. Beef organs contained more acidic phosphorus and acidic organic phosphorus than buffalo and mutton organs except, liver, lung and brain of buffalo which contained more content of acidic organic phosphorus. Inorganic phosphorus content was higher in buffalo organs than that of beef organs except heart and lung. Moreover, buffalo organs contained higher inorganic phosphorus than mutton organs.

Generally, lipophosphorus content in buffalo organs recorded higher content in all studied than that of beef organs, except heart and tongue. However, the mutton organs contained higher content of lipophosphorus than that of buffalo and heart of beef. Beef organs contained more protein phosphorus than buffalo except heart and lung. Moreover, mutton organs was higher in protein phosphorus than beef, buffalo except heart, spleen and lung. The values for phosphorus are generally higher in liver, kidney and spleen (Price, 1970). Such findings are in agreement with those reported by: Powick and Hoagland (1924), Watt and Merrill (1950), Schweigert and Payne (1956), Wright and Forsyth (1957) and Watt and Merill (1963).

II- Effect of prolonged frozen storage at -20°C on phosphorus fractions of meat organs: The influence of freezing and six months storage at -20°C on total, inorganic, lipid, acidic, protein and acidic organic phosphorus content are tabulated in Tables 2, 3 and 4.

-Total phosphorus: Tables 2, 3 and 4 indicated that the total phosphorus content in all studied organs decreased during frozen storage. According to John (1975), the total phosphorus in meat decreased during freezing and thawing. Results indicated that there were highly significant differences between organs, animals and period of storage. However, high significant interaction between organs and animals, and significant interaction between organs and period of storage, kind of animal and period of storage. Such findings are in agreement with these reported by Wright and Forsyth (1927), Watt and Merill (1963), Price (1970) and John (1975).

- The inorganic phosphorus: Results in tables 2, 3 and 4 indicated that the inorganic phosphorus in all studied organs increased rapidly during freezing and storage period. Such finding suggested that the inorganic phosphate increased during freezing (Motoc and Benu, 1968). Data revealed that there were highly significant differences between organs, animals and storage period. However, there was high significant interaction between organs and animals, significant interaction between animals and storage. Moreover, the interaction between organs and storage was insignificant. Furthermore, the accumulation of inorganic phosphorus fraction occurred may be due to the enzymatic hydrolysis of complex organic compounds as well as glycolysis and breakdown of the high energy phosphoric compounds. Such results are in agreement with those reported by Powick and Hoagland (1924), Motoc and Benu (1968), White et al. (1968) and Nawlan and Dyer (1974).

- The lipophosphorus: Tables 2, 3 and 4 showed that the lipophosphorus content of all organs studied decreased during freezing. Likewise such decrease was continued as storage period was advanced. Such finding suggested that the correlation coeffici-nt between total lipid and

phospholipid was negative (Kuchmak and Dugan, 1965). Furthermore, the decrease of lipophosphorus fractions taking place might be due to the hydrolysis of some complex organic compounds as phospholipids. Such finding confirmed the results of Kuchmak and Dugan (1965). Data showed that although there were highly significant differences between organs and storage periods, there was no significant differences between animals. Moreover, it has been found that the interaction between organs and animals was highly significant although it was significant between animals and storage periods. No significant interaction between organs and storage periods was recorded.

- Acidic phosphorus: Results in tables 2, 3 and 4 revealed that the acidic phosphorus content increased during freezing and storage period. However, the rate of increment was also reduced the storage period was advanced. Data showed that there were highly significant differences between organs, animals and storage periods. Moreover, highly significant interaction between organs and animals and significant interaction between animals and storage periods has been found. Meanwhile, there was no significant interaction between organs and storage periods. The consistent increase in acidic phosphorus content might be attributed to the rapid hydrolysis of the phosphorganic compounds. Such results are agreement with Powick and Hoagland (1924), White et al. (1968) and Nowlan and Dyer (1974).

- Acidic organic phosphorus: Tables 2, 3 and 4 indicated that the acidic organic phosphorus of all organs decreased gradually after freezing and during storage periods. Data showed that there was highly significant differences between organs, animals and storage periods. Moreover, highly significant interaction between organs and animals as well as between animal and storage periods. There was no significant interaction between organs and storage periods. The remarkable decrease in the organic acidic phosphorus content was probably due to hydrolysis of phosphorganic compounds. Such assumption is in full agreement with Nowlan and Dyer (1974).

- Protein phosphorus: Results given in 2, 3 and 4 indicated that the protein phosphorus content of the studied organs decreased markedly during freezing and storage periods. Data indicated that there was a highly significant differences between organs, animals and storage periods. Moreover, highly significant interaction between organs and animals, organs and storage periods and animals and storage periods. Such results explained that the more water content the more the rate of hydrolysis in the phosphoproteins compounds. That is why a rather consistent decrease in the phosphoprotein fraction generally took place, which conicides with White (1968).

Table 1.- Phosphorus fractions of fresh organs of beef, buffalo and mutton (mg/1 g on dry weight basis)

Animals	Organs	Kind of phosphorus					
		Total phos-phorus	Acidic phos-phorus	Inorganic phos-phorus	Lipo phos-phorus	Protein phos-phorus	Acidic organic phos-phorus
Beef	Liver	11.82	5.63	2.51	2.79	3.40	3.12
	Heart	8.95	4.26	1.62	2.46	2.23	2.64
	Kidney	9.75	4.68	2.15	2.75	2.32	2.53
	Spleen	13.29	6.21	2.70	3.23	3.85	3.51
	Brain	16.43	7.66	3.43	4.11	4.66	4.23
	Lung	10.23	5.03	2.07	3.03	2.17	2.96
	Tongue	6.06	2.71	1.08	1.64	1.71	1.63
Buffalo	Liver	11.36	4.81	2.82	3.15	3.40	1.99
	Heart	7.39	3.16	1.49	1.61	2.62	1.67
	Kidney	10.09	4.79	2.72	3.01	2.29	2.07
	Spleen	13.22	6.08	3.30	3.55	3.59	2.78
	Brain	15.22	6.99	4.18	4.59	4.28	2.81
	Lung	9.89	4.17	2.74	3.02	2.70	1.43
	Tongue	4.92	2.11	0.89	1.42	1.39	1.22
Mutton	Liver	11.77	4.89	2.74	2.98	3.90	2.15
	Heart	6.21	2.34	0.87	2.13	1.74	1.47
	Kidney	9.54	4.28	2.42	2.78	2.48	1.86
	Spleen	10.56	4.14	2.23	3.68	2.74	1.91
	Brain	14.99	6.49	3.66	4.16	4.34	2.83
	Lung	10.05	4.49	2.16	3.44	2.12	2.33
	Tongue	5.51	1.67	0.87	1.87	1.97	0.80

Table 2.- Effect of prolonged freeze storage at (-20°C) on phosphorus fractions in beef organs (mg/1 g).

Organs	Frozen storage period (Months)	Kind of phosphorus					
		Total phos-phorus	Acidic phos-phorus	Inorganic phos-phorus	Lipo phos-phorus	Protein phos phorus	Acidic organic phos-phorus
Liver	0	11.82	5.63	2.51	2.79	3.40	3.12
	2	11.10	5.74	2.69	2.51	3.10	3.05
	4	18.81	5.86	2.86	2.29	2.87	2.98
	6	10.55	5.98	3.01	2.11	2.62	2.96
Heart	0	8.95	4.26	1.62	2.46	2.23	2.64
	2	8.27	4.35	2.01	2.04	1.88	2.35
	4	7.75	4.49	2.23	1.79	1.46	2.26
	6	7.40	4.69	2.38	1.54	1.16	2.02
Kidney	0	9.75	4.68	2.15	2.75	2.32	2.53
	2	9.14	4.91	2.39	2.39	1.84	2.52
	4	8.75	4.97	2.59	2.12	1.66	2.37
	6	8.44	5.37	2.77	1.93	1.17	2.37
Spleen	0	13.29	6.21	2.70	3.23	3.85	3.51
	2	12.38	6.35	2.89	2.82	3.22	3.46
	4	11.88	6.49	3.11	2.47	2.91	3.39
	6	11.52	6.68	3.30	2.24	2.59	3.38
Brain	0	16.43	7.66	3.43	4.11	4.66	4.23
	2	15.27	7.82	3.64	3.63	3.98	4.12
	4	14.78	7.91	3.84	3.31	3.56	4.07
	6	14.35	8.11	4.08	3.01	3.22	4.03
Lung	0	10.23	5.03	2.07	3.03	2.17	2.96
	2	9.19	5.16	2.36	2.57	1.45	2.79
	4	9.88	5.28	2.51	2.31	1.29	2.77
	6	8.56	5.48	2.76	2.06	1.02	2.72
Tongue	0	6.06	5.71	1.08	1.64	1.71	1.63
	2	5.68	2.83	1.41	1.43	1.42	1.52
	4	5.35	2.94	1.51	1.19	1.22	1.45
	6	5.12	3.14	1.59	0.97	1.01	1.38

Table 3.- Effect of prolonged freeze storage at -20°C on phosphorus fractions in buffalo organs (mg/1 g)

Organs	Frozen storage period (months)	Kind of phosphorus					
		Total phos-phorus	Acidic phos-phorus	Inorganic phos-phorus	Lipo phos-phorus	Protein phos-phorus	Acidic organic phos-phorus
Liver	0	11.36	4.81	2.82	3.15	3.40	1.99
	2	10.83	4.91	3.22	2.88	2.04	1.69
	4	10.40	5.01	3.47	2.47	2.92	1.54
	6	10.02	5.75	3.79	2.07	2.70	1.46
Heart	0	7.39	3.16	1.49	1.61	2.62	1.67
	2	6.79	3.33	1.72	1.39	2.07	1.61
	4	6.15	3.74	2.14	1.12	1.29	1.60
	6	5.68	4.25	2.87	0.90	0.53	1.38
Kidney	0	10.09	4.79	2.72	3.01	2.29	2.07
	2	9.32	4.89	3.14	2.65	1.78	1.75
	4	8.62	5.51	3.78	2.34	0.77	1.73
	6	8.47	6.01	4.28	2.07	0.39	1.73
Spleen	0	13.22	6.08	3.30	3.55	3.59	2.78
	2	12.28	6.14	3.71	3.19	2.95	2.43
	4	11.56	6.16	3.88	2.82	2.58	2.28
	6	10.74	6.72	4.53	2.46	1.56	1.19
Brain	0	15.86	6.99	4.18	4.59	4.28	2.81
	2	14.71	7.07	4.65	4.13	3.51	2.42
	4	13.52	7.73	5.32	2.37	2.04	2.41
	6	12.63	8.26	5.97	3.36	1.01	2.29
Lung	0	9.89	4.17	2.74	3.02	2.70	1.43
	2	9.02	4.35	3.24	2.66	2.01	1.11
	4	8.27	4.73	3.73	2.37	1.55	1.00
	6	8.03	5.64	4.65	2.13	0.26	0.94
Tongue	0	4.92	2.11	0.89	1.42	1.39	1.22
	2	4.37	2.25	1.29	0.86	1.26	0.96
	4	4.11	2.41	1.34	0.72	0.98	0.57
	6	3.87	2.53	1.98	0.62	0.71	0.55

Table 4.- Effect of prolonged freeze storage at -20°C on phosphorus fractions in mutton organs (mg/1 g)

Organs	Frozen storage period (months)	Kind of phosphorus					
		Total phos-phorus	Acidic phos-phorus	Inorganic phos-phorus	Lipo phos-phorus	Protein phos-phorus	Acidic organic phos-phorus
Liver	0	11.77	4.89	2.74	2.98	3.90	2.15
	2	11.13	5.06	2.92	2.45	3.62	2.14
	4	10.86	5.29	3.17	2.17	3.40	2.12
	6	10.02	5.34	3.32	1.89	2.79	2.02
Heart	0	6.21	2.34	0.87	2.13	1.74	1.47
	2	5.54	2.45	1.06	1.83	1.26	1.39
	4	5.06	2.66	1.30	1.54	0.86	1.36
	6	4.72	2.85	1.61	1.27	0.60	1.24
Kidney	0	9.54	4.28	2.42	2.78	2.48	1.86
	2	8.89	4.65	2.89	2.39	1.85	1.79
	4	8.09	4.82	3.09	2.16	1.11	1.73
	6	7.67	5.09	3.41	1.71	0.87	1.68
Spleen	0	10.56	4.14	2.23	3.68	2.74	1.91
	2	9.75	4.33	2.61	3.22	2.20	1.72
	4	9.26	4.45	2.74	2.95	1.86	1.71
	6	8.69	4.74	3.06	2.51	1.44	1.68
Brain	0	14.99	6.49	3.66	4.16	4.34	2.83
	2	13.76	6.80	4.06	3.57	3.39	2.72
	4	13.07	6.90	4.23	3.19	2.95	2.70
	6	12.05	7.02	4.53	2.57	2.46	2.49
Lung	0	10.05	4.49	2.16	3.44	2.12	2.33
	2	9.02	4.76	2.74	2.76	1.50	2.02
	4	8.43	4.88	2.87	2.49	1.06	2.01
	6	7.60	4.94	3.14	2.05	0.71	1.80
Tongue	0	5.51	1.67	0.87	1.87	1.97	0.80
	2	4.11	1.86	1.12	1.39	0.86	0.79
	4	3.67	1.91	1.32	1.14	0.35	0.59
	6	3.23	2.03	1.83	0.95	0.25	0.20

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