J. Agric. Sci. Mansoura Univ., 31 (11): 7231 - 7244, 2006

EFFECT OF SOME GROWTH PROMOTERS ADDED TO RATIONS OF FRIESIAN CALVES ON QUALITIES AND COOKING PROPERTIES OF MEAT:

2. PHYSICAL CHARACTERISTICS AND CHEMICAL COMPOSITION OF FROZEN STORED *Longissimus dorsi* MUSCLE MEAT.

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ABSTRACT

This work was aimed to study the effect of some commercials growth promoters as fed additives (probiotics and enzymes) added to Friesian calves ration on physical characteristics and chemical composition during frozen storage at -20°C for 6 months. The results indicated that during frozen storage the tenderness water holding capacity (WHC) and colour intensity of meat progressively decreased with increasing the time of frozen storage in all samples of treated groups and control. The chemical composition of frozen meat for control group were lower than those of supplemented group with growth promoters after six months of frozen storage. The concentration of Copper, Manganese, Cadmium and Lead increased gradually with increasing the storage period of all meat samples. The results indicated that, the meat tissues can concentrate the heavy metals (cadmium and lead) inside it during frozen storage.

The results cleared that proportion of indispensable amino acids decreased in control samples comparing to samples post-mortem except cystine only. On the contrary, in frozen calve's meat fed ration supplemented with growth promoters (fibrozyme, moreyeast and pronifer), most of indispensable amino acids increased except cystine and tryptophan in fibrozyme group, valine and cystine in moreyeast and valine, cystine, phenylalanine and tryptophan in pronifer group.

The chemical score of amino acids in control samples showed limiting values than other treatment except tryptophan only. The highest value of computed protein efficiency ratio (C-PER) and biological value (BV) was in fibrozyme group followed by control, then moreyeast group, while it was very low in pronifer group.

Generally, it could be concluded that the frozen storage had negative effect on C-PER and BV in calve's meat fed on ration supplemented with growth promoters.

The results indicated also that a remarkable differences between the total saturated and unsaturated fatty acids during frozen storage of calve's meat fed on control ration and supplemented groups with growth promoters. In most of the cases total unsaturated fatty acids were higher than saturated fatty acids in intramuscular fat of meat post-mortem and during frozen storage.

INTRODUCTION

Meat is very important source of nutrients in human diet. Meat is important sources of protein, vitamins, minerals, fatty acids (Nottingham, 1971 and Jimenez *et al.*, 2001). Freezing and frozen storage can cause marked effects on the properties of meat. These effect may significantly

influence quality of meat and meat products produced from it (Paz-de-pena, *et al.* 1998). Also, many researchers showed that freezing and frozen storage for different kinds of meat can effect on meat quality and chemical composition (Kim *et al.*, 1991; Szmanko *et al.*, 1995; Cabanes *et al.*, 1995; Brzostowski *et al.*, 1995/1996; Cifuni *et al.*, 2001 and Andrade *et al.*, 2004).

Freezing is known to be one of the most suitable method for preservation of food items in general and especially meats (Morsi, 1988) So, the present study aimed to investigate the effect of some commercials growth promoters as feed additives (probiotics and enzyme) added to Friesian calve's ration on meat quality and chemical composition during frozen storage at -20°C for 6 months.

MATERIALS AND METHODS

This work was carried out at El-Karada Animal Production Research Station and Sakha Animal Production Research Laboratories, Kafr El-Sheikh Governorate, which belong to the Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Cairo, Egypt and Food Technology Department, Faculty of Agriculture, Kafr El-Sheikh, Tanta University.

Materials :

Twelve Friesian calves with average body weight 233.17 kg and 11 months, 20 days of age were used in this study. Concentrate feed mixture consisted of yellow corn 30%, cotton seed cake 20%, wheat bran 12%, rice bran 16%, soya bean cake 16%, sugar cane molasses 3%, lime stone 2% and salt 1% (Factory of Concentrate Feed Mixture, Shosha, Al-Minia Governorate, Egypt).

Experiment:

Animals were divided into four similar groups (three animals for each group) according to their live body weight and age. Average of initial live body weight were 234.67, 232.00, 229.33 and 236.67 kg for groups control, fibrozyme, moreyeast and pronifer, respectively.

The first group (control) was fed on a basal ration which consisted of concentrate feed mixture, rice straw and berseem hay without any feed additives supplementation.

The calves of the other three groups were fed the same basal ration with fibrolytic enzyme (fibrozyme obtained from industrial area, Jdeidet El-metn, Lebanon), yeast (*Saccharomyces cerevisiae*, (moreyeast product of norchem, USA) and lactic acid bacteria (pronifer product of P.G.E., Austria), as follow: 15 gm fibrozyme/head/day, 3-5 gm moreyeast/ kg concentrate feed mixture and 5-10 gm pronifer/100 kg live body weight.

Animals were fed to cover the requirements of dry matter, total digestible nutrients and digestible crude protein for growing calves according to National Research Council (1996) and the rations were adjusted biweekly according to the body weight changes.

Animals of the different main groups were kept during the experimental period in semi-open sheds and fed individually. The concentrate mixture was offered twice daily at 8 am and 3 pm, berseem hay was offered once daily at

11 am and rice straw was offered at 9 am. All feed additives were added to the concentrate feed mixture at the time of feeding daily Animals were allowed to drink water twice daily post-feeding in the morning and in the afternoon.

At the end of the feeding trials (six months), all animals were slaughtered after fasting period of 16 hours at an average weights 405, 446.67, 440 and 445 kg for control, fibrozyme, moreyeast and pronifer groups, respectively. Growth promoters supplementation led to significant in body weigth gain and daily weigth gain. Average relative daily body weigth gain during the experimemtal period (180 days) for calves supplemented with fibrozyme, moreyeast and pronifer increased by 125.26, 123.16 and 122.11%, compared with control group, respectively. Upon the completion of bleeding, animals were skinned, dressed out and the hot carcasses were weighted. Samples of meat were taken from *longissimus dorsi*, muscle and packed in polyethylene bags, each containing 1 kg. meat and frozen stored at -20°C for 6 months.

Methods :

Freezing, storage and thawing :

Frozen *Longssimus dorsi* muscle meat were thawed at room temperature (at 25°C), minced and mixed well then analyzed for physical characteristics and chemical composition.

Physical characteristics :

Longissimus dorsi muscle area was measured with planimeter in square centimeter, and fat thickness was measured using calipers as described by United States Department of Agriculture (1975). Specific gravity was determined on *longissimus dorsi* muscle cuts after chilling for 48 hours at 4°C as described by Soroor (1993).

Cooking loss was detected according to Dawood (1995) method. Tenderness and water-holding capacity (WHC) were investigated using the Grau and Hamm method (1957) modified by Volovinskaia and Merkolova (1958). Colour intensity of meat-water extract was tested according to the method described by Husaini *et al.* (1950). pH value was measured by using pH meter with glass electrode as described by Aitken *et al.* (1962).

Chemical composition :

Gross Chemical composition :

Moisture content, ash, crude protein and ether extract were determined in frozen *Longissimus dorsi* muscle meat according to the methods of AOAC (1995).

Total soluble nitrogen (TSN) was measured according to the method of El-Gharbawi and Dugan (1965). The extracted nitrogen was used for determination of TSN using microkjeldahl method of the AOAC (1995).

Minerals contents :

Minerals were determined according to Dremina *et al.* (1974) method. Frozen meat samples were digested using concentrated HNO_3 for 2 hours (till the solution became colourless) and diluted to 100 ml distilled water. The solution was used for determination of Ca, Fe, Cu, Mg, Mn, Pb, Zn and Cd using PYE Unicam SP 1900 Atomic Absorption Spectrophotometer, at

Central laboratory, Faculty of Agriculture, Alex. Univ. Sodium and potassium were determined in the same solution by the Flame photometer. Total phosphorus was estimated in the digested solution colorimetrically according to the method of Tausky and Shorr (1953).

Amino acids analysis :

Amino acid composition (except tryptophan) of frozen muscle meat were determined according to the method of Moore and Stein (1958). Amino acids in hydrolyzate samples were injected into amino acid analyzer Model 119 CL at Central Laboratory, Fac. of Agric., Alex. Univ. Egypt. Tryptophan was colorimetrically determined according to the method described by Kogan and Pojarskaya (1971).

Amino acid score (AAS): was computed according to Pellet and Young (1980).

Computed protein efficiency ratio (C-PER): was calculated according to the following regression equation by Alsmeyer *et al.* (1974).

Biological value (BV): was calculated using equation as given by Block and Mitchell (1946).

Fatty acids composition :

Extraction of fat from frozen muscle meat was done according to the method described by Folch *et al.* (1957).The fatty acid are converted to the methyl esters following the procedure adopted by Shehata *et al.* (1970),and injected into the gas liquid chromatography apparatus (PYE Unicam GCV Chromatography), in the central laboratory Fac. of Agric. Alex. Univ. Egypt.

Statistical analysis :

Data were statistically analyzed using general linear models procedure adapted by SPSS (1997) for user's guide, with one way ANOVA; means were separated using Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of frozen storage at –20°C for 6 months on the physical characteristics of *Longissimus dorsi* muscle meat as affected by different growth promoters supplemented with the experimental rations of Friesian calve's are presented Table (1). The results showed that during frozen storage, the tenderness, water holding capacity (WHC) and colour intensity decreased in all samples as the time of frozen storage increased. The decrease in tenderness could be ascribed to the increase of protein denaturation, oxidation and aggregation during storage as mentioned by Dyer and Dingle, (1967), Hafiz (1973) and Mohamed (1974).

The marked decrease of WHC during frozen storage at -20°C of meat in all samples was in accordance with the decrease of protein solubility (Table 1) and this phenomenon has been also attributed to a mechanical loosening of the muscle tissue by the formation of ice crystals inside the cells (Miller *et al.*, 1980).

The decrease of colour intensity during frozen storage could be attributed to both oxidation of meat pigments (myoglobin and oxymyoglobin) to form metmyoglobin of brown colour and to the escape of meat pigments with the separated drip during thawing which increased as the time of storage

increased. The degradation of colour could be attributed also the microbial action of some bacteria as pseudomonas which usually cause marked biochemical changes in meat pigments as mentioned by (Pavlovski and Palmin, 1963).

Table (1): Physical characteristics of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 3 and 6 months) of Friesian calves fed ration supplemented with different growth promoters.

Growth promoters	Physical characteristics							
	Tenderness (cm^2)		Water holding capacity (cm^2)		Colour intensity		PH value	
	Months							
	3	6	3	6	3	6	3	6
Control	2.25 ^{b}	2.23	9.29	9.68 ^{a}	0.38 ^{a}	0.36 ^{a}	5.65	5.85
Fibrozyme	2.50 ^{a}	2.39	8.08 ^{B}	9.70 ^{Aa}	0.35 ^{a}	0.33 ^{a}	5.51	5.79
Moreyeast	2.35 ^{ab}	2.25	8.63 ^{B}	10.29 ^{Aa}	0.28 ^{b}	0.20 ^{b}	5.52	8.88
Pronifer	2.58 ^{a}	2.51	8.24	8.89 ^{b}	0.37 ^{a}	0.34 ^{a}	5.62	5.77
MSE	0.05	0.06	0.24	0.18	0.02	0.02	0.30	0.05

a, b and c: means in the same row with different superscripts differ significantly (P < 0.05).
A and B significance between months.
MSE: Means of standard error.

It could be observed that pH value were decreased after 3 months of frozen storage compared to the initial values of all samples,while after 6 months the pH values rasied again but in moreyeast and pronifer groups the values were slightly less than the initial values.The decrease of pH during frozen storage for 3 months could be ascribed to the breakdown of glycogen and formation of lactic acid (Mohamed, 1974). This indicated that autolytic change are not prevented at -20°C and occurred at a lower rate of low storage temperature while the raising of pH value for control and fibrozyme groups than the initial value could be ascribed to the influence of proteolysis which happened in the tissue and produced nitrogenous bsic compounds. The results obtained are in agreement with those obtained by Kim *et al.* (1991) who found that pH values of meat during frozen storage showed the lowest value after one month and thed tended to increase gradually.

Chemical composition :

The effect of frozen storage at -20°C for 6 months on the chemical composition of *longissimus dorsi* muscle meat as affected by different growth promoters supplemented with the experimental rations of Friesian calves are presented in Table (2). The moisture content reduced continuously as the time of frozen storage increased. The decrease of water may be due to evaporation losses during frozen storage and to the drip losses from the thawed frozen meat. The results showed also that the rate of water loss was highest for control, while was lowest for moreyeast group followed by fibrozyme and pronifer groups after 6 months of frozen storage at –20°C. The results cleared that during frozen storage (at -20°C) the crude protein of all meat samples declined as the time of frozen storage increased, which could be due to the drip loss during thawing which contain a part of nitrogenous compounds. The loss of nitrogenous compounds after 6 months of frozen

storage were higher in fibrozyme group than other treatments, followed by moreyeast group then control and pronifer groups (% in the proportion to the initial value).

The results obtained showed that the value of ether extract after 3 months increased in control and fibrozyme groups, while decreased in moreyeast and pronifer groups. After 6 months the value of ether extract increased in control, fibrozyme and moreyeast groups, while decreased in pronifer group only compared to the initial values postmortem.

Table (2): Gross chemical composition of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 3 and 6 months) of Friesian calves fed ration supplemented with different growth promoters (% of dry matter).

Growth promoters	Chemical compositions									
	Moisture		Dry matter		Crude protein		Ether extract		Ash	
	Months									
	3	6	3	6	3	6	3	6	3	6
Control	74.89^{b}	74.02^{b}	25.11^{a}	25.98^{a}	80.18^{a}	78.40^{a}	10.20	10.51^{a}	4.34	4.12^{a}
Fibrozyme	76.03^{ab}	75.53^{a}	23.97^{b}	24.47^{b}	78.43^{b}	77.56^{b}	10.10	10.09^{a}	4.42	4.17^{b}
Moreyeast	76.33^{a}	75.74^{a}	23.67^{ab}	24.26^{b}	80.86^{ab}	79.00^{ab}	9.42	9.44^{b}	4.60	4.08^{bc}
Pronifer	75.38^{ab}	75.04^{ab}	24.62^{ab}	24.96^{ab}	80.58^{ab}	79.92^{ab}	9.87	9.29^{b}	4.39^{A}	3.85^{Bc}
MSE	0.22	0.27	0.22	0.27	0.21	0.23	0.07	0.09	0.01	0.01

a, b and c: means in the same row with different superscripts differ significantly (P < 0.05).
A, B significance between months.
MSE: Means of standard error.

The changes took place in the total content of ether extract might indicate both hydrolysis and oxidation of fat.

On the other hand, the increase of the ether extract contents could be due to the decrease of the total nitrogen during frozen storage time, while the decrease in ether extract could be ascribed to that the formation of ice crystals caused mechanical damage of the tissues and the possible escape of some intra-and intermuscular fat with the separated fluids (drip).

The results in Table (2) cleared that during frozen storage, ash content of all meat samples were decreased after 3 and 6 months as the time of frozen storage increased. The decrease of ash content in meat during frozen storage could be attributed to considerable amounts of minerals that escaped with the separated fluid (drip) during thawing.

Nitrogenous compounds :

It was observed from Table (3) that soluble non protein nitrogen and soluble protein nitrogen values decreased progressively as the time of frozen storage increased in all samples at 3 and 6 months. The decrease of total soluble nitrogen could be interpreted by denaturation and aggregation of proteins as a result of increasing the salt concentration in tissue because of freezing of muscle water at -20°C as well as due to the oxidation of lipids. The end products of lipids oxidation and hydrolysis are able to react with proteins decreasing their solubility (Dyer and Dingle, 1967, Awad *et al.*, 1968 and Shehata, 1974).

Table (3): Some nitrogenous components of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 3 and 6 months) of Friesian calves fed ration supplemented with different growth promoters (% of wet matter).

Growth promoters	Nitrogenous components					
	Total soluble nitrogen		Soluble non protein nitrogen		Soluble protein nitrogen	
	Months					
	3	6	3	6	3	6
Control	1.37 ^{A}	1.30 ^{B}	0.48 ^{A}	0.39 ^{Bb}	0.89	0.91 ^{a}
Fibrozyme	1.40	1.30	0.58	0.46 ^{ab}	0.82	0.84 ^{ab}
Moreyeast	1.35	1.32	0.48	0.46 ^{ab}	0.87	0.86 ^{ab}
Pronifer	1.48	1.27	0.54	0.53 ^{a}	0.94	0.74 ^{b}
MSE	0.04	0.007	0.02	0.02	0.03	0.02

a, b and c: means in the same row with different superscripts differ significantly ($P < 0.05$).
A, B: significance between months.
MSE: Means of standard error.

The decrease in soluble nitrogenous compounds might be also due to losses of some water soluble nitrogen compounds in drip during thawing.

The results obtained are in agreement with those given by Kijowski and Niewiarowiez (1980) who found that non protein nitrogen concentration dropped during 6 months of storage at -18°C. The results obtained by Fahmy *et al.* (1981) supported these results.

Minerals contents :

The results in Table (4) cleared that during frozen storage most of minerals were scattered. It could be noticed that Na value increased after 3 months of frozen storage comparing with the initial values for all samples, then decreased rapidly and became less than the initial value. The concentrations of Cu, Mn, Cd and Pb increased generally with increasing the storage period of all meat samples.

On the other hand, K, P, Ca, Mg, Fe and Zn decreased gradually with increasing of frozen storage time except Ca at 3 months in fibrozyme group and Zn after 3 months in control group, their values became more than the initial values.

The decreases of mineral concentrations occurred during frozen storage of meat could be due to losses in the separated drip during the thawing of meat. It seemed possible that not only the amount of drip affected the rate of losses in individual minerals, but also the intensity of damage and porosity of tissues had also some effect.

Results showed also that the meat tissues can concentrate the heavy metals (Cd and Pb) inside it during frozen storage.

Protien quality :

Amino acids:

Amino acids in meat of *Longissimus dorsi* muscle as affected by frozen storage at -20°C for 6 months and growth promoters supplemented with the experimental rations of Friesian calves are tabulated in Table (5).

Table (4): Minerals contents of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 3 and 6 months) of Friesian calves fed ration supplemented with different growth promoters (mg/100 gm dry matter).

Minerals	Growth promoters							
	Control		Fibrozyme		Moreyeast		Pronifer	
	Months							
	3	6	3	6	3	6	3	6
Sodium (Na)	1359.42	274.02	1533.42	251.66	1707.31	311.46	1133.71	252.12
Potassium (K)	757.71	518.63	585.02	534.33	573.85	443.82	491.27	410.06
Phosphorus (P)	492.55	307.47	486.15	237.84	490.45	364.18	766.77	364.70
Calcium (Ca)	123.38	52.23	146.35	71.27	115.21	63.52	110.80	67.03
Iron (Fe)	123.50	82.41	122.86	87.99	142.12	133.47	143.95	102.28
Copper (Cu)	17.05	11.55	14.77	12.22	18.46	11.46	14.54	12.22
Magnesium (Mg)	0.68	0.27	0.79	0.33	0.63	0.29	0.81	0.40
Manganese (Mn)	0.28	0.12	0.42	0.33	0.63	0.37	0.41	0.28
Zinc (Zn)	11.07	9.24	10.89	9.64	12.89	8.53	12.10	11.38
Cadmium (Cd)	0.49	0.64	0.54	0.84	0.75	0.92	0.94	1.61
Lead (Pb)	6.61	6.58	3.25	2.82	2.96	3.54	2.19	1.96

Table (5): Amino acids composition of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 6 months) of Friesian calves fed ration supplemented with different growth promoters (g/16 g N)

Amino acids	Growth promoters				
	Control	Fibrozyme	Moreyeast	Pronifer	FAO/WHO 1973 standard P. g/16 g N
Indispensable amino acids:					
Thereonine	3.97	5.73	4.99	5.46	4.00
Valine	5.03	6.29	4.46	5.32	5.00
Methionine	2.17	2.88	2.73	3.00	
Cystine	0.53	0.41	0.42	0.30	3.50
Isoleucine	3.89	5.62	5.04	4.97	4.00
Leucine	5.52	7.30	6.52	6.84	7.00
Phenyalanine	3.66	4.33	4.15	3.76	
Tyrosine	3.10	3.58	3.27	3.57	6.00
Lysine	6.36	8.82	7.64	9.00	5.50
Tryptophan	1.15	1.10	1.10	1.12	1.00
Histidine	3.49	4.07	4.00	4.22	
Arginine	7.77	6.01	5.36	7.07	
Total indispensable amino acids	47.09	56.14	49.68	54.63	
Dispensable amino acids					
Aspartic acid	8.55	9.68	9.71	10.17	
Serine	3.36	5.26	4.05	3.94	
Glutamic acid	17.51	18.02	16.85	18.14	
Proline	3.61	2.90	3.93	3.66	
Glycine	2.09	4.65	4.19	4.24	
Alanine	5.48	6.30	5.79	5.70	
Total dispensable amino acids	40.15	46.81	44.52	45.85	
Total amino acids	87.24	102.95	94.20	100.48	
Indispensable/total amino acids	0.54	0.55	0.53	0.54	

It could be observed that proportions of indispensable amino acids decreased in control samples comparing to samples post-mortem except cystine only. On the contrary in frozen calves' meat fed ration supplemented

with growth promoters (fibrozyme, moreyeast and pronifer), most of indispensable amino acids increased except cystine and tryptophan in fibrozyme group, valine and cystine in moreyeast, and valine, cystine, phenyl alanine and tryptophan in pronifer group. The results cleared that,the growth promoters had a great effect on the proportions of indispensable amino acid in the samples of frozen meat. Also growth promoters had effect on the indispensable/total amino acids in frozen meat comparing to the initial values.

Amino acids score:

The results obtained in Table (6) reported that the amino acid score of all indispensable amino acids showed good improvement in calves' meat of fibrozyme, moreyeast and pronifer groups with exception valine in moreyeast group and tryptophan in calves' meat of fibrozyme, moreyeast and pronifer groups.

Table (6): Amino acids score of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 6 months) of Friesian calves fed ration supplemented with different growth promoters.

Amino acids (indispensable)	FAO/WHO (1973) standard P mg/gm N.	Growth promoters							
		Control		Fibrozyme		Moreyeast		Pronifer	
		A.A. mg/gm N	AAS	A.A. mg/gm N	AAS	A.A. mg/gm N	AAS	A.A. mg/gm N	AAS
Isoleucine	250	243.13	97.25	351.25	140.50	315.00	126.00	310.63	124.25
Leucine	440	345.00	78.41	468.75	106.53	407.50	92.61	427.50	97.16
Lysine	340	397.50	116.91	551.25	162.13	477.5	140.44	562.50	165.44
Methionine + cystine	220	168.75	76.70	205.63	93.47	196.88	89.49	206.25	93.75
Phenylalanine+tyrosine	380	422.50	111.18	494.38	130.10	463.75	109.76	458.13	120.56
Threonine	250	248.13	99.25	358.13	143.25	311.88	124.75	341.25	136.50
Valine	310	314.38	101.41	393.13	126.82	278.75	89.92	332.50	107.26
Tryptophan	60	71.88	119.80	68.75	114.58	68.75	114.58	70.00	116.67

A.A. = Amino acid
AAS. = Amino acid score

$$AAA = \frac{\text{Mg of amino acid per gm. N. in tested protein}}{\text{Mg of amino acid per gm. N. in reference protein (FAO / WHO, 1973}} \times 100$$

The chemical score of amino acids in control samples showed limiting values than other treatments except tryptophan only.

The calculated results in Table (6) revealed that frozen storage had good improvement in the amino acid score of indispensable amino acids in calves' meat of fibrozyme, moreyeast and pronifer groups.

Data showed also that, the sulfur-containing amino acids (methionine + cystine) gave the minimal score for all samples, but it was less in control than other treatments. The same trend in sulfur-containing amino acids in the initial values.Leucine was the second limiting amino acid in protein of frozen meat for control and treatments, although the amino acid score of leucine in fibrozyme group showed improvement, while the amino acid score of leucine in moreyeast and pronifer groups was higher than the control.

Computed protein efficiency ratio (C-PER) and biological value (BV):

The computed protein efficiency ratio (C-PER) and biological value (BV) of frozen meat of longissimus *dorsi* muscle as affected by frozen storage at -20°C for 6 months and different growth promoters supplemented with the experimental rations of Friesian calves are shown in Table (7).The highest value of C-PER was in fibrozyme group followed by control, then moreyeast group, while it was very low in pronifer group. Generally, it could be concluded that the frozen storage had negative effect on C-PER and BV in calves' meat fed on ration supplemented with growth promoters.

Table (7): Computed protein efficiency ratio (C-PER) and biological value (BV) of frozen stored *Longissmus dorsi* muscle meat (at -20°C for 6 months) of Friesian calves fed ration supplemented with different growth promoters.

Growth promoters	C-PER	BV
Control	1.89	69.80
Fibrozyme	1.98	70.45
Moreyeast	1.86	69.49
Pronifer	1.59	66.64

C-PER = -1.816 + 0.435 meth. + 0.781 leu. + 0.211 his -0.944 tyr. (Alsmeyer *et al.*, 1974)
BV = 49.9 + 10.53 x PER (Block and Mitchell, 1946)

Fatty acids composition:

The changes in fatty acids composition in frozen stored meat of *longissimus dorsi* muscle as affected by frozen storage time at -20°C for 6 months and different growth promoters supplemented with the experimental rations of Friesian calves are tabulated in Table (8).

It was noticed that there was a remarkable differences observed between the total saturated and unsaturated fatty acids during frozen storage of calves' meat fed on control ration and supplemented groups with growth promoters (fibrozyme, moreyeast and pronifer).

Data in Table (8) showed that $C_{18:1}$ represented the dominant fatty acid of total unsaturated fatty acids among the investigated samples followed by $C_{18:2}$, while the major components of saturated fatty acids were $C_{16:0}$ and $C_{18:0}$. After 3 and 6 months of frozen storage $C_{16:0}$ constituted the major portion of saturated fatty acids in control and moreyeast groups. While $C_{18:0}$ was the major component of saturated fatty acids in fibrozyme and pronifer groups.

The ratios of total unsaturated and saturated fatty acids in calves' meat fed on control ration and supplemented groups with growth promoters (fibrozyme, moreyeast and pronifer) after 3 and 6 months of frozen storage were 1.19, 1.02; 0.92, 1.07; 1.10, 1.22 and 1.08, 1.30, respectively. These ratios decreased in calves' meat fed on ration supplemented with fibrozyme, moreyeast and pronifer comparing to the initial values, while it was higher in control group than the initial value.

The decrease in total unsaturated fatty acids in intramuscular fats in frozen meat during storage time might be due to oxidation and degradation of unsaturated fatty acids, while the increase in the other samples due to the formation of more hydroperoxides and peroxides (Fahmy *et al.*, 1981). The

changes in fatty acids composition could be also due to hydrolysis of phospholipids by phospholipases (Sarvadeva and Srikar, 1982).

In most of the cases total unsaturated fatty acids were higher than saturated fatty acids in intramuscular fat of meat post-mortem and during frozen storage.

Table (8): Fatty acids composition of frozen stored *Longissimus dorsi* muscle meat (at -20°C for 3 and 6 months) of Friesian calves fed ration supplemented with different growth promoters (% of total fatty acids).

Fatty acids	Growth promoters							
	Control %		Fibrozyme %		Moreyeast %		Pronifer %	
	Months							
	3	6	3	6	3	6	3	6
Unsaturated fatty acids:								
Palmitoleic acid ($C_{16:1}$)	3.15	2.96	2.35	2.78	3.1	3.94	2.20	3.70
Oleic acid ($C_{18:1}$)	37.56	40.25	34.85	34.62	39.71	36.27	38.67	41.27
Linoleic acid ($C_{18:2}$)	12.46	6.06	8.93	11.97	7.39	12.26	9.98	9.77
Linolenic acid ($C_{18:3}$)	1.15	1.21	1.77	2.24	2.12	2.55	1.00	1.86
Tatal monoenoic fatty acids %	40.71	43.21	37.20	37.40	42.89	40.21	40.87	44.97
Total polyenoic fatty acids%	13.61	7.27	10.70	14.21	9.51	14.81	10.98	11.63
Total unsaturated fatty acids%	54.32	50.48	47.90	51.61	52.40	55.02	51.85	56.60
Saturated fatty acids:								
Lauric acid ($C_{12:0}$)	0.53	0.24	0.31	0.27	0.30	0.23	0.40	0.12
Myristic acid ($C_{14:0}$)	2.11	2.37	2.32	2.00	2.39	2.04	2.16	1.86
Palmitic acid ($C_{16:0}$)	24.45	23.59	23.44	22.46	22.40	23.98	22.36	20.17
Stearic acid ($C_{18:0}$)	18.22	22.78	25.79	23.15	22.29	17.88	22.84	20.73
Behenic acid ($C_{22:0}$)	0.38	0.54	0.25	0.53	0.22	0.85	0.40	0.52
Total saturated fatty acids%	45.69	49.52	52.11	48.41	47.60	44.98	48.16	43.40
Unsaturated/saturated fatty acids	1.19	1.02	0.92	1.07	1.10	1.22	1.08	1.30

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تأثير إضافة بعض محفزات النمو الى علائق عجول الفريزيان على جودة وخواص الطبخ للحم:
٢- الخواص الطبيعية والتركيب الكيميائى للحم العضلة الطولية الظهرية المخزن بالتجميد.

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أجرى هذا البحث بهدف دراسة تأثير إضافة بعض محفزات النمو (فيبروزيم، موربيست، برونيفير) المستخدمه تجاريا كإضافات غذائيه الى علائق عجول الفريزيان لمدة ١٨٠ يوم على جودة لحم العضلة الطولية الظهرية أثناء التخزين بالتجميد على درجة –٢٠°م لمدة ٦ شهور حيث أوضحت النتائج ما يلى :

- حدوث تناقص تدريجى فى الطراوة والقدرة على الإمساك بالماء للحم بزيادة مدة التخزين بالتجميد لجميع المعاملات والكنترول.
- كما حدث نقص فى التركيب الكيميائى للحم فى معاملة الكنترول مقارنة بالمعاملات الأخرى خلال التخزين بالتجميد.
- أثناء التخزين بالتجميد زادت نسبة عناصر النحاس والمنجنيز والكادميوم والرصاص تدريجياً بزيادة فترة التخزين فى كل المعاملات حيث أوضحت النتائج أن أنسجة اللحم تستطيع أن تركز وتحفظ العناصر الثقيلة مثل الكادميوم والرصاص فى أنسجتها خلال التخزين بالتجميد.
- نسبة الأحماض الأمينية الأساسية فى بروتين اللحم أثناء التخزين بالتجميد على –٢٠°م لمدة ٦ شهور تناقصت فى معاملة الكنترول ما عدا السيستين على العكس فى اللحوم الناتجة من معاملات محفزات النمو فقد ذادت معظم الأحماض الأمينية ما عدا السيستين والتربتوفان فى معاملة الفيبروزين والفالين والسيستين فى معاملة الموربيست والفالين والسيستين والفينايل أنالين والتربتوفان فى معاملة البرونيفير.
- خلال التخزين بالتجميد أظهر الرقم الكيميائى للأحماض الأمينية الأساسية تحسن فى كل المعاملات والكنترول.
- نسبة كفاءة البروتين والقيمة الحيوية للبروتين كانت أقل أثناء التخزين بالتجميد.
- وجدت اختلافات ملحوظة فى الأحماض الدهنية المشبعة والغير مشبعة أثناء تخزين اللحم بالتجميد فى كل المعاملات والكنترول.
- فى معظم المعاملات فإن الأحماض الدهنية الغير مشبعة الكلية كانت نسبتها أعلى من الأحماض الدهنية المشبعة فى الدهن بين الألياف العضلية فى اللحم أثناء فترة التخزين بالتجميد.