STUDIES OF SOME POST MORTEM CHANGES OF BUFFALO MEAT

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Introduction

Enormous studies concerning the changes in the meat of different sp. of farm animalo were carried out to investigate the effect of autolysis on the dynamic changes of carbohydrate system in meat (Bate - smith, 1947, 1948, 1949, 1956; Pavlovski, 1956; Bendall, 1962). The changes of proteins during the storage of meat (Smarodentsev, 1939; Erdos, 1943; Salaviev, 1952, Sakariov and El-dashlouty, 1963, El-Ashry and El-Dashlouty, 1967), and the changes of meat properties during tenderisation (Paul, 1944, Sakalov and El-Dashlouty, 1963, El-Ashry and El-Dashlouty, 1967). Investigations included Rabbit (Bendall, 1951), Cow (Salaviev, 1952) Sheep (Sakalov and El-Dashlouty,1963, El-Ashry and El-Dashlouty, 1967), horse (Lawrie, 1955), Pig (Bendall, 1963) and poultry (de-Fremery, 1960). To the outhers knowledge no studies were carried out concerning the post-mortem changes of buffalo meat. Since this type of meat is widely spread and consumed in Africa and Asia, the present study was suggested to deal with some biochemical and technological changes of two muscles of buffalos during autolysis.

The break-down of glycogen after slaughtering, takes place either through glycolysis, producing lactic acid or through amylolysis resulting in the formation of reducing sugars. The process of glycolysis is prevailing during the first 24 hours of autolysis and is responsible for the destruction of 90% of glycogen. Amylolysis predominates after 24 hours of slaughtering and is responsible for the breat-down of about 10% of glycogen (Juravskaia, 1954).

According to Bate-smith (1949) the acidity of muscular tissues observed immediately after slaughtering, depends on the struggling and the efforts exerted by the animal during slaughtering.

However, the observed acidity at rigor mortis, is due to the amount of stored glycogen. Whence the present authors suggest that the maximum amount of lactic acid can be used as an indicator of the original amount of the glycogen stored in muscles and liver.

The decrease in the p H value of muscular tissues is closely related to the water holding capacity of boiled and unboiled meat, which in turn controls the amount of drip during the thawing of frozen meat. Hamm (1958) and 1959) observed that the decrease in p H value is responsible for one third of the decrease in the water holding capacity of muscular tissues, the break down of A T P, however is responsible for 2/3 of the decrease in the water holding capacity.

Sakalov (1951) claims that the decrease in the water holding capacity of muscular tissues is due to the formation of Actomyosin through the combination of actin and myosin and minimizing the free groups that are able to hold water. This demiutionis considered by the present authors to be the main direct cause of the decrease of the water holding capacity. The break-down of ATP is an indirect cause of the decrease of water holding capacity resulting in the association of actin and myosin with the formation of actomyosin complex.

Different amounts of ATP, glycogen and creatin-phosphate are observed in the different muscles of the animal which depend on the function and physiological state of muscle and consequently the degree of autolysis differs according to the different muscles

(Howard, 1957)

The general chemical composition of the animal tissues as a whole depends upon its physiological state. It was observed that the exercising and training of muscles (alternative work and rest) increases the amount of stored glycogen in the tissues by 40% (Bate-smith, 1948).

From the above stated review it can be seen that, the amount of stored glycogen in the animal tissues at the time of slayghtering is of great effect on the technological properties of meat such as the water holding capacity, a fact which can be more pronounced if the relation between the water holding capacity of meat and the meat tenderness is taken into consideration (Wierbicki, 1956).

The higher amount of glycogen in the muscular tissues at the time of slaughtering, which enables the reconstruction of a high amount of ATP, delays the attack of rigor mortis.

The above mentioned discussion reveals that in order to study the autolytic processes of buffalo meat should stress on the changes of lactic acid and degrees of water holding capacity and plasticity.

Materials and Methods

The longissimus dorsi and Biceps Femoris muscles of three buffalo males were used in the present studies. The animals were 2 years old and 400 kg. kilograms in weight. Samples were taken immediately after slaughtering and after, 1, 2, 3, 5, and 8 days of storage at 4° C. Acidity (Sakalov, 1953) water holding capacity and plasticity (Valavinskaia, 1958) modified after Graw and Hamm (1957) were estimated for each sample.

Results and Discussion

The lowest acid content of the muscular tissues was observed immediately after slaughtering. This low value increases with storage to reach a maximum and then decreases again (table 1):

Table (1)

The acidity of the buffalo muscles during autolysis (in mg - per 100 gr)

Periods of autolysis	Biceps Femoris			Longissimus dosi		
	Animal I	Animal II	Animal III	Animal I	Animal II	Animal III
Immediately after slaughtering	295,3	351,8	354,6	451,8	567,7	334,4
after 24 of"	546,8	516,8	589,0	519,2	637,7	461,1
" 48 " "	612,1	627,0	650,8	614,0	657,0	528,0
" 72 " "	678,4	669,4	780,2	614	686,1	739,2
5 days " "	646,8	725,0	788,3	596,0	701,7	517,8
8 " " "	582,0	598,0	644,0	588,0	649,0	477,0

As the amount of the estimated acid is proportional to the amount of glycogen exhibting in the muscular tissues before slauhtering, the authors expect that the greatest amount of glycogen may have been existing in the animal "III" and the smallest in the animal "I".

The maximum observed amount of the acid estimated during storage see seems to have no relation with the initial value observed direct after slaughtering. The amount of the acid observed immediately after slaughtering is related to the struggling of the animal during slaughtering (Bate-smith, 1949).

The amount of the for-met acid is inversly proportional with the water holding capacity of the animal tissues (tables 1 and 2).

Table(2)

The water holding capacity of the buffalo muscles during autolysis (in cm^2)

Periods of Autolysis	Biceps Femoris			Longissimus dorsi		
	Animal I	Animal II	Animal III	Animal I	Animal II	Animal III
Immediatly after slaughtering	2,40	3,60	7,62	2,50	3,00	1,20
after 24 hours of"	7,92	7,70	10,20	6,66	7,78	6,90
" 48 " " "	8,18	8,57	10,30	8,04	8,33	7,80
" 72 " " "	6,63	7,90	8,47	7,03	7,33	7,80
" 5 days "	6,30	6,50	7,55	6,90	7,20	7,23
" 8 " "	6,00	6,40	7,33	6,90	7,15	7,23

Comparing the different maxima of the amount of the formed acid it is observed that the animal charachterized by the highest maximum is also charachterized by the lowest water holding capacity and plasticity at the end of tenderisation. Thus it can be infered that the higher the amount of glycogen at the time of slaughtering the lower the water holding capacity and plasticity (tables 2 and 3) at the end of tenderisation, whence it is recommended not to offer food to the animal for 24 hours before slaughtering inoder to get rid of the stored glycogen in the muscular tissues.

Table (3)

The plasticity of the buffalo muscles during autolysis (in cm

Periods of autolysis	Biceps Femoris			Longissimus dorsi		
	Animal I	Animal II	Animal III	Animal I	Animal II	Animal III
Immédiately after slaughtering	3,60	2,97	2,77	3,63	3,60	3,80
after 24 hours "	2,30	2,12	2,13	2,37	2,25	3,06
" 48 " "	2,08	1,84	1,72	1,90	1,68	2,05
" 72 " "	2,21	1,96	1,92	2,05	1,68	2,45
" 5 days "	2,42	2,10	2,00	2,25	2,25	2,50
" 8 " "	2,52	2,40	2,13	2,60	2,40	2,33

The attack of rigor mortis is a funition of the amount of the stored glycogen in the muscular tissues before slaughtering. It was found that is most studied cases the higher amounts of glycogen in the muscular tissues at the time of slaughtering delayes the regor mortis (table 4), whence it is recommended to fe the animal before slaughtering whenever it will be directly consumed without tenderisation.

Table (4)

The amounts of changes in plasticity (% of change of original valure)

Periods of autolysis	Biceps femoris			Longissimus dorsi		
	Animal I	Animal II	Animal III	Animal I	Animal II	Animal III
after 24 hours of Slaughtering	36,14	29,60	23,10	34,71	37,50	19,4
" 48 " "	42,22	46,95	37,06	47,38	53,33	46,0

In accordance with the results obtained from table (4) are the those of Bate-smith and Bendall (1956). They observed that the greater the glycogen amount in the animal tissues before slaughtering the lower the rate of the break-down of ATP, the slower the attack of rigor mortis and whence, the longer the period through which meat is still charachterized with tenderness.

It is worth mentioning that the amount of glycogen is not the only effective factor on the appearance of rigor mortis. (Sakalov (1965) stated that the break-down of ATP results in the dissociation of actin and myosin forming actomyosin fibers. Actomyosin fibers with the energy liberated from the break-down of ATP are contracted to increase the hardness of meat.

The studying of the charachteristics of longissimus dorsi and Biceps fermoris muscles of Buffalo males at three periods of autolysis immediately after slaughtering, after 2 days of storage (rigor mortis) and after 8 days of storage (tenderisation) revealed that the longissimus dorsi is more tender and of higher water holding capacity than the Biceps Fermoris muscle in 77% of the studied cases. However the acid formed in the longissimus dorsi muscle is lower in only 33% of the cases than the acid content of the Biceps femoris muscle. (Tables 1,2,3).

The formely mentioned argument concerning the charachterisics of longissimus dorsi and Biceps Femoris may easily reveal that the content of the formed acid is not the only factor that effect the meat properties during autolysis.

The observation showes that the longissimus dorsi has greater water holding capacity and plasticity than the Biceps femoris. It might be explained that the latter is more active during the

Table (1) shows that the Biceps femoris containes more stored glycogen than the longissimus dorsi. This due to its activity during the animal life. As a support to this idea was the data obtained by Bate-smith in 1948. The same author stated that the alternation of working and resting of muscles results in a more glycogen amount in the muscular tissues compared with the glycogen amounts in the continuous by working or continuously resting muscle.

It can be also observed from the data presented in table (1) that the increase in the amount of the produced acid may reach 207% at the top of rigor mortis (after 24 hours of slaughtering) of an original value (100%) observed immediately of after slaughtering. The amount of the acid increased gradualy but with a slow rate. The produced acid at 3-5 days of storage may attain 165% of a value equals 100% observed after 2 days of slaughtering. The rigor mortis reasched its maximum after 48 hours of slaughtering but the amount of the formed acid continues increasing, an observation that needs an explanation. Two forms of glycogen exist in the muscular tissues at slaughtering; easily extracted and difficulty extracted glycogen. The latter consists of greater number of glycose molecule. The present authors suggest that the difficulty extracted glycogen may change into easily extracted glycogen before changing into lactic acid, and that the formation of lactic acid may be likely from the easily extracted glycogen. Whence the amount of glycogen continues increasing after the top of rigor mortis and even during the late periods of autolysis. Salaviev, 1951, 1952, 1956. Lawrie, 1959, stated that the difficulty extracted glycogen may change into the easily extracted glycogen, and that the two forms of glycogen continuously decreased during autolysis.

The delay of the maximum acid formation 3 days after the top of the rigor mortis revealed that the amount of the formed lactic acid is not the only factor affecting meat properties during autolysis.

The data presented in table 5 reveals that the amount of acid in liver continuously increased by storage. Taking in consideration the maximum amount of the acid as an indication for the level of the stored glycogen in lives before slaughtering the animals may be arranged with respect to their glycogen content as follow: I, III and II (the maximum glycogen content amount is expected in I animal). This arrangement differs from that resulted if the muscular glycogen content is used which may be interpreted to be due to that the considered maxima of lactic acid in liver is not true maxima and different results may be obtained by longer storage.

Table (5)

The acidity of the buffalo liver during autolysis (mg per 100gm)

Periods of autolysis	Animal I	Animal II	Animal III
Immediately after slaughtering	209,6	197,7	200,5
after 24 hours " "	299,1	221,2	260,9
" 48 " " "	463,2	221,7	275,8
" 72 " " "	468,5	245,1	352,8
" 5 days " "	488,2	317,7	407,6
" 8 " " "	488,5	351,5	429,6

Pavlovski (1963) stated that the rate of glycogen break-down of the in liver slowes than in muscular tissues and that the pH values was higher in liver than in the muscular tissues. He also addes that in liver an appreciable amount of residual glycogen is encountere.

Krilova (1957) claimed that acidity in liver is mainly due to phosphoric acid and that the acidity in muscular tissues is mainly due to lactic acid.

By the end of storage, after the maximum amount of the formed acid is observed, a decrease in acidity is encountered. This observation are in agreement with the results obtained by Sakalov and El-Dashlouty, 1963, and El-Ashry and El-Daschlouty, 1967. Salaviev (1966) believes that the diffincy of acidity is due to autolytic and not microbiological changes.

The majority of improvements in the charachteristics of buffalo meat (plasticity) and water holding capacity) does not take place before the fifth day of storage at 4°c. Therefore the minimum limit of storage for buffalo meat at 4°c is the fifth day to obtain meat of good quality.

The trends of autolytic changes in buffalo do not differ in a hall from those, in other species of farm animals. The difference only lies in the degree of these changes.

According to Salaviev (1966) the minimum period of storage of cow carcus at 4°c to obtain tender meat is 10 days. He also added that the rigor mortis of cows is of 48 hours of storage whence it can be readily seen that autolytic changes in buffalo meat is more rapid than in cow meat. Sakalov and El-Dashlouty (1963) stated that the top of the rigor mortis of sheep meat is at 24 hours of the storage at 0°c. Therefore the autolytic changes in buffalo meat is slower than those in sheep meat.

<u>Conclusions</u>:

From the above mentioned studies and analysis general conclusions may be summarized as follows:-

It was observed that the water holding capacity, plasticity and the amount of the formed acid in the muscular tissues are different in the different muscles of the same animal and also differs from animal to animal. The charachteristics of longissimus dorsi muscle were in generally better than those of the Biceps femoris muscle.

In order to obtain a meat of good quality after tenderisation, it is recommended to get rid, as far as possible, of the stored glycogen by keeping the living animal away of food for about 24 hours before slaughtering. However, fresh meat of good quality without tenderisation may be obtained by feeding and resting the animal before slaughtering in order to increase the amount of stored glycogen in muscular tissues. The existence of great amounts of glycogen delays the attack of rigor mortis.

The storage of buffalo meat at 4°c for at least 5 days is recommended to obtain tender meat of good auality.

The autolysis in the liver is of lower rate than that observed in muscular tissues.

Autolysis and consequently tenderisation in buffalo meat are of a higher rate as compaired by mutton. However the rate of autolysis and tenderisation of cow meat are slower than those of buffalo meat. The general trend of changes in buffalo meat due to a autolysis does not differ than that observed with the other farm animals. The difference lies only in the intensity and the rates of these changes.

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