Meat quality of "Mediterrâneo" *Bubalus bubalis* and "Nelore" *Bos indicus* breeds

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SUMMARY: From 38 buffaloes and 29 bovines considered in a research on buffaloes as a meat producers, 10% of the first and 24% of the second group presented of DFD (pH ≥ 6.2), or intermediate (6.0 ≤ pH < 6.2) conditions in their *longissimus dorsi*. *Extensor carpi ulnaris*, *flexor digitorum superficialis*, *l.dorsi*, *psoas major*, *sartorius*, *triceps brachii*, and *vastus lateralis* muscles from lots consisting of buffaloes and bovines showed lower pH, except one, in the first group. Muscles related to movement presented highest values, above 6.0, while *l.dorsi*, showed the lowest, in both species. In the *l.dorsi* of two lots of 8 buffaloes and 6 bovines, thawing and cooking losses were lower in DFD than in normal bovine meat (P<0.05). Shear and adhesion presented lower values for buffalo meat, and lower in DFD compared to normal muscle. In thawed and drained normal muscle, mean moisture values were lower for buffaloes. The total pigments were on average higher in buffalo muscles.

INTRODUCTION: As part of an overall research program on buffaloes this investigation evaluated their meat quality for fresh consumption.

The removal of animals from their environment, transport and delivering to the abattoir restrainer are the widely recognized determinants for the stressfull pre-slaugheter conditions in different levels. The best known deleterious effect in cattle is the DFD condition. Although still fit for consumption DFD meat, also known as dark cutting beef presents undesirable colour and reduced shelf life. This is caused by an ante-mortem depletion of glycogen and a consequent reduction of post-mortem glycolysis. Dark cutting beef has a high ultimate pH relative to normal beef. The 24 hour pH is one of the methods to identify this abnormality.

When meat is freshly cut, the colour is the purplish red of reduced myoglobin. On exposure to air, oxygen is absorved at the surface, forming bright cherry-red oxymyoglobin. However, the muscle of DFD not brightens. In DFD meat, due to high pH, the activity of cytochrome oxidase is high, demanding high amount of oxygen. It lowers the oxygen available for conversion to oxymyoglobin. The other important appearence of DFD meat is the stick lean surface, due to its higher water retention capacity. This high water content confers a more continuous lean structure and promotes a decrease in the reflection of incident light, contributing to a darker colour (EPLEY, 1978; NORMAN, 1978; and DYETT et al. 1981).

Although there is some controversy on the pH limit, in general, values of 6.2 or above taken after 24 hours of bleeding are considered characteristic of the DFD condition, and meats with a pH 6.0 to 6.2 as of intermediate between normality and DFD, and pH lower than 6.0, as of normal conditions (WIRTH, 1980).

The pH below 6.0 in the centre of *l.dorsi* is recommended by the Brazilian Federal rules for exportation purposes. For more recent shipments, this limit has been reduced by some of the importing countries even for lower levels of pH 5.9. Above this level the meat has its microbiological stability reduced.

Incidences of 8% of dark cutting beef in Canada and 3.2% in Ireland has been mentioned (MUNNS & BURRELL, 1966 and SHERIDAN, 1982). In the United States, a country that performs official carcass classification and grading of animals carcasses involving prices according to their quality, the Agricultural Department reported an economic loss, of cerca 21 dollars for a 600 pounds carcass due to grading in a lower category of DFD meat carcasses (EPLEY, 1978). There is no Brazilian official statistical data but an incidence of 30% has been mentioned.

MATERIALS AND METHODS:

Animals - Thirty eight buffaloes and 29 bovines of different lots from experimental farms of the Instituto Zootecnia (IZ) and from private farm were taken and slaughtered by the same staff in the IZ or Centro de Tecnolo da Carne abbatoirs. The slaughtering jointing, deboning and cutting up procedures were according to the Brazili Federal Rules. The characteristics of lots *i*, *ii*, *iii*, *iv*, *v*, *vi*, *vii*, *viii*, and *iv* are shown in Table 1.

Samples preparation - *L.dorsi* muscles over the rib eye at 12th rib from every right side carcasses were taken frozen and stored for pH determination purpose.

Five lots consisted of "Mediterrâneo" buffaloes *i*, *v* and *vi*, and of "Nelore" bovines *ii* and *viii* had their *e.carpi ulnaris*, *f.digitorum superficialis*, *l.dorsi*, *p.major*, *sartorius*, *t.bracchii* (caput longum), and *v.lateral* muscles removed from the right side carcasses, detached from bones or fascias at aparent leans, and trimmed o separable fat and of covering connective tissues. Each muscle combined by lot were homogeneized. Samples up t 3kg were taken by quartering and packed in polyethylene bags, frozen and stored at -18^{o}C.

Two other lots of 8 buffaloes *iii* and 6 bovines *iv*, 17 to 20 months old entire males reared in semi-confin management had their bone in the *l.dorsi* muscles cut off with the outside fat over the rib eye, between 8 to and 12 to 13 ribs, packed in polyethylene bags, frozen and stored as above. Before the analysis, *l.dorsi* muscles from both species were thawed at 0 to 3^{o}C during 48 hours and deboned.

One cm layers from both ends were cut out, and sliced from anterior to posterior direction in 1.0, 2.5, 3.0, 2.5 and 1.0cm steaks. Both of the 2.5cm steaks were separated for cooking, and the rest of them had the rib eye separated for chemical determinations.

Analysis - Determination of pH was performed on all excised muscles, and moisture, protein, fat, and total pigments were carried out on *l.dorsi* according to KONIECKO (1985).

Two 2.5cm steaks of each animal from lots *iii* and *iv*, were trimmed off to 1cm fat over the rib eye and roasted in an 177^{o}C oven to an internal temperature of 72^{o}C. Thawing and cooking losses were determined by weigh differences. Warner-Bratzler forces were measured by Instron, in 0.5in. diameter cilinders taken from cooked steaks, paralel and transversaly to fibers for shear and adhesion, respectively. Pressed juice was determined as described by BAKER et al. (1968).

The data were evaluated by the one-way cross classification analysis of variance and the means were compared by Tukey-test at 5% level of significance.

RESULTS AND DISCUSSION: The pH measurement is usualy used to assess both, the quality of muscles and the suitability for various processing methods. The results of *l.dorsi* pH of several lots of buffaloes and bovines showed a lower incidence of 10% of DFD condition in the first group, and 24% for the latter (Table 1). The lower susceptibility to stress for buffaloes was reported previously by VALIN et al. (1984). Compared to other lots, the *iii* and *iv* consisted of young animals between 17 to 20 months presented higher susceptibility to stress in both species. One buffalo among 8 showed the intermediate condition; and 1 and 2 bovines among 6, the intermediate and DFD conditions, respectively.

Table 2 shows the pH variation observed in several muscles of lots, *i*, *v*, *vi* which consisted of buffaloes and lots *ii* and *viii* of bovines. In both species, *extensor* and *flexor* muscles which are the most related to movement presented higher pH, above 6.0; while *l.dorsi* had the lowest values, between 5.48 to 5.84. *P.major* also averaged similar to the *l.dorsi*, for buffaloes (5.31 to 5.49) but not for bovines (6.01 and 6.17). Lot *i* of buffalo muscles presented systematically lower pH than correspondent ones of bovine lot *ii*, both of entire males of same age and management. Bovine lots presented abnormal conditions (pH > 6.0) in all studied muscles, except in *l.dorsi*. In buffaloes lot only *extensor* and *flexor* had pH above 6.0.

Table 1. Incidence of normal, intermediate and DFD conditions in buffaloes and bovines.

Specie	Lot	Description	Number of animals: Total	Normal pH < 6.0	Intermediate 6.0 ≤ pH < 6.2	DFD pH ≥ 6.2
Buffaloes "Mediterrãneo"	*i*	Entire males, 23 to 26 months, pasture	4	4	0	0
	iii	Entire males, 17 to 20 months, semi-confined	8	7	1	0
	v	Femeles, 4 to 11 years, pasture	4	4	0	0
	vi	Femeles, > 15 years, pasture	4	4	0	0
Not defined	*vii*	Not defined	18	15	1	2
		Total	38(100%)	34(90%)	2(5%)	2(5%)
Bovines "Nelore"	*ii*	Entire males, 23 to 26 months, pasture	4	4	0	0
	iv	Entire males, 17 to 20 months, semi-confined	6	3	1	2
	viii	Entire males, 23 to 26 months, semi-confined	6	5	0	1
Not defined	*ix*	Not defined	13	10	1	2
		Total	29(100%)	22(76%)	2(7%)	5(17%)

pH taken in *l.dorsi* muscles.

The characteristics of boneless *l.dorsi* steaks from lots *iii* and *iv*, separated according to pH range are shown in Table 3. Thawing and cooking losses, and pressed juice did not differ statistically between species but differed between meat pH ranges. The objective force in shearing and adhesion measurements related to tenderness were statistically different between species, lower for buffaloes, and only shearing was different between pH ranges of cattle meat. With regard to shear force of raw meat, VALIN et al. (1984) reported lower values in Murrah buffaloes muscles compared to that from red Bulgarian cattle, both reared under the same conditions.

Table 2. pH variation in different muscles from buffaloes and bovines.

Muscle (Site)	Buffaloes Lot *i*	Buffaloes Lot *v*	Buffaloes Lot *vi*	Bovines Lot *ii*	Bovines Lot *viii*
Extensor carpi ulnaris (Foreshank)	6.28	6.30	-	6.74	6.74
Flexor digitorum superficialis (Hindshank)	6.21	6.02	6.07	6.42	6.33
Longissimus dorsi (Rib eye roll)(1)	5.49	5.48	5.69	5.61	5.84
Psoas major (Tenderloin)	5.47	5.49	5.31	6.01	6.17
Sartorius (Inside round)	5.62	5.54	5.56	6.04	6.02
Triceps brachii (caput longum) (Shoulder)	5.69	5.55	5.60	6.11	6.13
Vastus lateralis (Knuckle)	5.62	5.56	5.56	6.04	5.98

(1) Average of thawed and drained muscles.

Table 3. Characteristics of *l.dorsi* from buffaloes and bovines, according to the pH range.

Specie / Range	Nr. of animals	Losses(%) Thawing $\overline{M}$	Thawing SD	Cooking $\overline{M}$	Cooking SD	Pressed juice(%) $\overline{M}$	Pressed juice SD	Warner Bratzler force (kgf/0.5 in) Shearing $\overline{M}$	Shearing SD	Adhesiveness $\overline{M}$	Adhesiveness SD
"Mediterrãneo" *iii*											
pH < 6.0	7	10.0^a	0.8	35.1^a	1.4	38.8^b	1.9	3.4^b	0.1	2.5^b	0.1
6.0 ≤ pH < 6.2	1	4.9	-	23.4	-	51.6	-	3.3	-	2.5	-
"Nelore" *iv*											
pH < 6.0	3	9.2^a	1.5	35.3^a	5.8	42.0^{ab}	4.1	4.5^a	0.3	3.3^a	0.3
6.0 ≤ pH < 6.2	1	5.2	-	37.9	-	40.0	-	3.6	-	2.1	-
pH ≥ 6.2	2	5.0^b	1.4	26.5^b	2.6	49.1^a	4.6	3.6^b	0.6	2.8^{ab}	0.6

Entire males, 17 to 20 months old, reared in semi-confined management.
ab means within each column bearing the different superscripts are significantly different (P < 0.05).
$\overline{M}$ = mean value, SD = standard deviation.

Thawed and drained *l.dorsi* samples obtained during preparation of the steaks for cooking presented statistical significant differences in moisture and total pigment content between species, but not between bovine pH ranges. ROBERTSON et al. (1983) determined by Hunter L, a and b, darker lean meat surfaces of buffalo *semitendinosus* and *semimembranosus* than of the Brahmans, being the L values significantly lower for buffaloes (Table 4).

Table 4. Moisture, protein and fat contents of thawed and drained *l.dorsi* from buffaloes and bovines.

Specie Lot	Range	Animals	Moisture(%) M̄	SD	Protein(%) M̄	SD	Fat(%) M̄	SD	Total pigments (ppm) M̄	SD
"Mediterrâneo" *iii*	pH < 6.0	7	74.1[b]	0.9	23.1[a]	1.1	1.9[a]	0.5	186[a]	16
	6.0 ≤ pH < 6.2	1	75.1	-	23.2	-	2.8	-	214	-
"Nelore" *iv*	pH < 6.0	3	75.8[a]	0.9	22.3[a]	1.4	2.3[a]	2.0	134[b]	34
	6.0 ≤ pH < 6.2	1	74.9	-	21.6	-	4.3	-	151	-
	pH ≥ 6.2	2	76.2[a]	0.9	21.5[a]	0.0	1.1[a]	0.3	157[ab]	6

Entire males, 17 to 20 months old, reared in semi-confined management.
[ab] means within each column bearing different superscripts are significantly different ($P < 0.05$).
M̄ = mean, SD = standard deviation.

CONCLUSION: Similary to bovines, buffaloes presented pre-slaughtering stress characterized by abnormal high pH, above 6.0, in their muscles. However buffaloes showed less susceptibility than bovine to develop DFD conditions.

Buffaloes and bovines can present distinct pH in muscles from several anatomical origins, the movement demanding muscles presenting higher pH in both species. *L.dorsi* might be one of the lowest pH muscles in the carcass for buffaloes and bovines. Therefore, depending on the anatomical localization, lean muscles of the same carcass can present different shelf life stabilities.

Young buffaloes presented cooked meat more tender than bovines of the same age and management conditions, and in bovines, cooked DFD meat was more tender than normal one.

Buffalo meat presented a higher amount of total pigments compared to bovines of the same age, sex and management.

The results of the investigation would be improved if a larger number of animals was to be examined, and further work needs to be carried out to confirm this view.

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