Buffalo for Meat Production

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BUFFALO FOR MEAT PRODUCTION
GIOVANNI de FRANCISCIS, ITALY

SUMMARY

Only very recently buffaloes have been studied deeper for a better breeding and for emphasizing their meat productive potentiality and its physiological, chemical and organoleptic qualities.

Very good investigations, conducted mainly in Australia, Bulgaria, Italy, Thailand and Trinidad show in an univocal way, if the buffaloes are reared and fed well, that the daily gain, the percentage of dressing and of the first cut, the organoleptic characteristics are quite similar and sometime also better than those of bovine cattle. The best slaughter time is at 14-16 months of age when the live weight is of 350-380 kg with a 52-58 percent of dressing. The A. emphasizes the use of balanced food in function of the different environmental situation, of appropriate breeding techniques and the application of a selective program for the development of genetic lines with high food conversion index to increase considerably the availability of buffalo meat.

Also, the opportunity is emphasized of extending the A.P.He.A. (Animal Production and Health Association) to every buffalo breeding country for fixing a research protocol to compare the different results so to plan a common approach in the buffalo research.

INTRODUCTION

From domestication until few decades ago the buffaloes were principally bred as work animals or as milk producers.

In the evolution of the domesticated species Macgregor (1941) has distinguished two types: the River and the Swamp; many other (Mohadevan, 1983) three types: River, Swamp and Mediterranean. The last is really quite similar to the River type and respectively they represent the 66.7%-29.7% and 3.6% of the world buffalo population. The first and the third type are heavier, averaging 600 kg with black coating and a good aptitude to milk production and work too; the second with a non characteristic and very often speckled coating and a preminent aptitude to work, and an average weight of 450 kg. This type includes several breeds with large weight differences among them.

The breeding system is still traditional and therefore connected to the breeders impossibility to integrate and?qor increase quantitativeli and qualitatively the insufficient availability of forages and food offered by quite a difficult environment. These particular conditions have determined that now the domestic buffalo is an animal very resistant to difficult environmental conditions, an in-comparable utilizor of coarse forage, intelligent, docile when not ill treated, long lived, very strong, yet with a structure not quite correct, and with acceptable muscular masses.

Meat production, once, was in fact not considered useful so that it was nearly always supplied by the underfed ones: i.e. the young exceeding the remount quote and the old at the end of their productive career (22-25 years old) and those eliminated because scarcely productive or injured. In many countries buffalo meat was, ISTITUTO DI ZOOTECNICA, Universita di Napoli, Cattedra di Zootecnica I:
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and still is not considered as an additional production because regarded as a low source of income with scarce nourishing value.

Only in recent years decisive attention has been given to the buffalo as a source of quality meat. Very deep and complete investigations conducted mainly in Australia, Bulgaria, Italy, Thailand, Trinidad and Yugoslavia have confirmed that if water buffaloes are reared, managed and fed for slaughter at 12 to 18 months of age they give a very good meat with optimum liveweight (Tab. 1-2-3-4).

Tab. 1: BODY WEIGHTS OF BUFFALOES AT VARIOUS AGES

<table>
<thead>
<tr>
<th>Breed</th>
<th>Birth</th>
<th>6 Months</th>
<th>12 Months</th>
<th>18 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murrh</td>
<td>29.3</td>
<td>118.6</td>
<td>212.1</td>
<td>324.7</td>
</tr>
<tr>
<td>&quot; grades</td>
<td>29.3</td>
<td>118.6</td>
<td>211.8</td>
<td>325.7</td>
</tr>
<tr>
<td>Nili-Ravi</td>
<td>30.5</td>
<td>133.9</td>
<td>218.8</td>
<td>355.8</td>
</tr>
<tr>
<td>&quot; grades</td>
<td>29.9</td>
<td>123.5</td>
<td>205.8</td>
<td>339.7</td>
</tr>
</tbody>
</table>
| Heritability | 0.21-0.74 | 0.43    | 0.73      | 0.43(0.23=AF)}


Tab. 2: RANGES OF MEANS FOR SIZE & GROWTH OF SWAMP BUFFALOES (Chantakhana, 1981)

<table>
<thead>
<tr>
<th>Traits</th>
<th>Unit</th>
<th>Range of \bar{x}</th>
<th>Traits</th>
<th>Unit</th>
<th>Range of \bar{x}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight</td>
<td>kg</td>
<td>26-38</td>
<td>Mature weight</td>
<td>kg</td>
<td>450-650</td>
</tr>
<tr>
<td>3 month weight</td>
<td>kg</td>
<td>125-150</td>
<td>Male</td>
<td>kg</td>
<td>450-650</td>
</tr>
<tr>
<td>Preweaning gain</td>
<td>kg</td>
<td>0.34-0.41</td>
<td>Female</td>
<td>kg</td>
<td>350-450</td>
</tr>
<tr>
<td>Yearling weight</td>
<td>kg</td>
<td>135-205</td>
<td>Height</td>
<td>cm</td>
<td>120-137</td>
</tr>
<tr>
<td>Post-weaning gain</td>
<td>kg</td>
<td>0.34-0.75</td>
<td>Girth</td>
<td>cm</td>
<td>180-209</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Length</td>
<td>cm</td>
<td>121-157</td>
</tr>
</tbody>
</table>

Tab. 3: MATURE WEIGHT AND SIZE OF SWAMP BUFFALOES

<table>
<thead>
<tr>
<th>Countries</th>
<th>Weight (kg)</th>
<th>Height (cm) M</th>
<th>Height (cm) F</th>
<th>Length (cm) M</th>
<th>Length (cm) F</th>
<th>Girth (cm) M</th>
<th>Girth (cm) F</th>
</tr>
</thead>
<tbody>
<tr>
<td>China *</td>
<td>450-600</td>
<td>136</td>
<td>126</td>
<td>157</td>
<td>151</td>
<td>204</td>
<td>202</td>
</tr>
<tr>
<td>China</td>
<td>400-450</td>
<td>129</td>
<td>124</td>
<td>143</td>
<td>132</td>
<td>188</td>
<td>179</td>
</tr>
<tr>
<td>Indonesia</td>
<td>450-500</td>
<td>130</td>
<td>125</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indonesia**</td>
<td>500-600</td>
<td>127</td>
<td>124</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Malaysia</td>
<td>364-545</td>
<td>129</td>
<td>121</td>
<td>123</td>
<td>121</td>
<td>183</td>
<td>180</td>
</tr>
<tr>
<td>Philippines</td>
<td>520</td>
<td>-</td>
<td>125</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Philippines</td>
<td>364-545</td>
<td>127</td>
<td>120</td>
<td>-</td>
<td>-</td>
<td>196</td>
<td>184</td>
</tr>
<tr>
<td>Taiwan***</td>
<td>400-450</td>
<td>129</td>
<td>124</td>
<td>141</td>
<td>135</td>
<td>196</td>
<td>190</td>
</tr>
<tr>
<td>Thailand****</td>
<td>404-600</td>
<td>121-137</td>
<td>121-126</td>
<td>141-148</td>
<td>132-137</td>
<td>186-209</td>
<td>181-183</td>
</tr>
</tbody>
</table>

1 Modified from Camoens (1976) with additional references as noted: * Liu (1978); ** Hardjosubroto and Astuti (1980); *** Ma (1980); **** NaPhuket (1980).

M = Male; F = Female.

Source: Chantakhana, 1984.
At present, while the importance as a work animal is slowly and constantly diminishing, researchers, scholars, technicians and breeders are becoming more interested to its potential meat productive capacity, and this also in consideration of the important role that it showed to have in the economic development of world poor areas and difficult habitats where it revealed to be more productive than bovine for work, meat and milk.

As a matter of fact the buffalo is nowadays bred in all the Continents (Tab.5)

<table>
<thead>
<tr>
<th>Tab.5</th>
<th>WORLD BUFFALO DISTRIBUTION: 1970, 1979 and 1982 (***))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1970 *</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td>120,079,000</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td>2,209,000</td>
</tr>
<tr>
<td><strong>North-Centr.America</strong></td>
<td>7,000</td>
</tr>
<tr>
<td><strong>South America</strong></td>
<td>226,000</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td>116,493,000</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>338,000</td>
</tr>
<tr>
<td><strong>USSR</strong></td>
<td>460,000</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td>160,000</td>
</tr>
</tbody>
</table>

Source: ** FAO Production Year Book, vol. 25-26-30; * W.R. Cockrill–Authors estimate

*** Author estimate.
and its number is in a continuous, progressive increase. To day in Brazil only there are 1.5 millions.

The first study to our knowledge on buffalo meat quality dates back to 1874 when F. Zoccoli conducted one for a competition published by the Agricultural Union of Naples, Italy on "...how to determine with practical means the signs to compare the meat of buffalo animals of all ages to the bovine". After that are worth mentioning the papers of Nasotti (1886), Mures (1896), Moscheroni (1909) and the classic publication of E.C. Santojanni (1910).

The investigations developed up to now, during the past 15 years, in all the Countries where the buffalo is bred, have given the opportunity to control in depth the few and superficial notions on breeding, feeding and meat quality that we had and to confirm the considerable rusticity, docility and intelligence as also the good meat and milk potential productivity of the animals, under the urge of increasing meat availability to satisfy the growing human consumption of animal proteins, and have aimed simultaneously to ascertain the physical, chemical and organo-peptic characteristics of meat and to improve the weight daily gain of young buffaloes.

Correlated Responses

Present research work is not limited to meat quality and quantity but it naturally includes all the diverse factors that, directly or indirectly, contribute to increase meat availability, quality and costs, calving intervals, sanitary problems, selection, rational feeding, breeding techniques, etc...

The buffalo at age 6 months utilizes proteins better than bovine of same age (Harvej, 1963). Iochponani and Sidhu (1965) have observed that the buffalo veal (18-24 months of age) utilizes low quality food and non-proteic nitrogen better than the zebu; Akram and Malik (1971), on fistulized males, have observed that buffaloes digest all kinds of food better than zebu. According to Part and Roj (1968) buffaloes, compared to bovines, better synthesize proteins. Again compared to bovine the digestion of fibre, according to Iochponani and Sidhu (1966), Singh and Mudgal (1967), Razdan (1968) and Devendra (1972) is faster in the buffalo, well adapted to low quality pastures. Johnson (1967) has noticed that food digestibility is 5 to 7% higher in buffaloes than in bovine, whereas other Authors (Gupta and Majumdar, 1962; Jang and Majumdar, 1962; Raghavan et al., 1963) believe no difference to be among the two species.

Angelo Salerno (1941) has shown with comparative studies on food utilization capacity of bovine and buffalo growing females that the consumption of F.U. to determine gain of a kilogram of live weight was lower in buffalo (U.F. 4.29 in
ring the summer for 94 days, with a similar food, the Authors noticed a mean daily gain of kg 0.700 with a dietary conversion index of 6 F.U. The different growth between the two groups of animals was explained as the effect of the season. Highly significant differences in weight gain in the first year of life, according to different periods of the year have been described by Balasubramanja et al. (1976) on males and females of Surti race and by Malik et al. (1980) in buffaloes grown in India.

The early weaning of buffaloes with the use of alfalfa hay and concentrated pellets after the third week of life is reached between 48 and 60 days of life according to Ferrara et al. (1970). Animals weaned in such fashion have reached a live weight of 175 kg at 6 months with a mean consumption of 2.70 F.U. per kg of live weight. The daily mean gain was of 816 grams and the dressing percent at slaughter was of 50.6%. The Authors have noticed that the buffalo veal is not really ready to utilize solid food before age 40 days. Complete weaning was, however, completed in 2 weeks.

Later experiments conducted in Egypt by Raafat et al. (1971) have confirmed that early weaning, if rationally performed, does not damage the following growth rate. For the production of the large buffalo veals above 400 kg of weight, Ferrara et al. (1972) have studied whole and castrated animals. With the use of meals mainly made of cereals, poor of fibre and good for the production of propionic and butyric acids and with a nutritional value of 1.84 F.U. per 100 kg of live weight, eliminated by castration (Zicarelli et al., 1975). It is also worth mentioning, about the so called "urine smell" of the meat, the relatively high incidence in the Buffalo species of kidney diseases that increases with aging (Roperto, 1979; Cortesi and Vaccaro, 1981).

When compared to bovines of same weight and of milk producing races it is quite high the negative incidence of the feet and the skin (respectively 2.83% and 13.49% over the slaughtered weight). The organoleptic qualities of the meat have always been considered good (Minieri et al., 1970; Ferrara et al., 1970). In the skeletal muscles (M. Longissimus Dorsi) the highest amino acidic concentration has been found in the sarcoplasmatic fraction (Balestrieri et al., 1973; Colonna et al., 1975); the content of lysine is elevated as in bovines (Balestrieri et al., 1973; Cutinelli et al., 1975).

In male buffaloes grown in Egypt, Taha et al. (1979) have found at age 58 weeks, a mean weight of 291.5 kg and a dressing percent at slaughtering of 55.7%. During the periods between 12-24, 24-38, 38-50 and 50-58 weeks the mean weight gains were of grams 336.3; 566.4; 785.7 and 919.6 respectively.

Rosca et al. (1980) in two groups of large buffalo veals in Rumania have described a mean live weight of kg 386 at 15 months of age and kg 397 at 18 months with a consumption of 6.38 and 6.69 F.U. per kg.

The works of Matassino et al. (1976) and Cosentino et al. (1976) have shown that the meat of buffalo veals has a fat percentual content very close to that of bovines.

The weight of 440 kg was reached at age 16 months with a mean daily gain of kg 0.883 in the whole ones and kg 0.851 in the castrates and with a consumption
of 5.593 and 5.670 F.U. respectively per increment of a kg of live weight. The dressing percent at slaughter was of 56.77% in the whole animals and 57.83% in the castrates. In the latter group the incidence of the "fifth dietary fourth" resulted lower for the lower weight of the feet and the skin. It seems, therefore, that in buffaloes, as in bovines, castration gives a certain degree of gentleness. The meat of the castrated animals showed a slightly less dark coloration (Ferrara et al., 1972; Minieri et al., 1972; Intrieri et al., 1972; Di Lella et al., 1972).

Varshnej et al. (1981) have castrated Indian buffalo veals at age 6 and 12 months by four different methods and have found that subjects castrated at 6 months by the Baiburtcojan method revealed at slaughtering better and more tender meats than those of the whole or castrated by other methods.

Di Lella et al. (1975) have found that for buffaloes, as with males of most milk producing bovines, it is not recommendable to produce subjects for slaughtering heavier than 400-450 kg. In fact in whole subjects the mean liveweight of 635 kg was reached at age 30 months and that of 706 kg only at age 42 months; in castrated subjects, at same ages, the mean weights were 632 and 710 kg. It has also been noticed that the muscles of these animals release a strong smell of musk that is attenuated but not to Girolami et al. (1975) in veals of 28 weeks of age, the meat is, instead, for some chosen muscles, more lean than that of Frisone bovines of same age.

Gigli et al. (1980) in male buffaloes of 36 weeks have found, compared to coagiers of Frisone race, a larger quantity of subcutaneous fat (7.28% vs. 4.56%), an equivalent amount of muscular fat (6.78% vs. 6.48%) and less perirenal and pelvic fat (1.65% vs. 2.48%). It must be noticed that the use of not refined forages has determined in buffaloes a noticeable increase of fat.

According to the work of Natasasmita and Tulloh (1978) in Indonesia the carcasses of the swamp female buffalo was richer of fat and poorer of connective tissue than that of males of same weight. The fat is white because there are no pigments. As of its acidic composition (Tab. 6), the buffaloes fat is richer of oleic and stearic acids that have been

<table>
<thead>
<tr>
<th>Acid</th>
<th>Buffalo Young Bull</th>
<th>Bovine Young Bull</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitic</td>
<td>18.3 ± 1.42</td>
<td>29.2 (26.7-31.0)</td>
</tr>
<tr>
<td>Stearic</td>
<td>24.4 ± 3.54</td>
<td>21.0 (17.3-27.7)</td>
</tr>
<tr>
<td>Palmitic Oleic</td>
<td>3.0 ± 0.29</td>
<td>4.4 (3.6-4.9)</td>
</tr>
<tr>
<td>Oleic</td>
<td>44.1 ± 4.45</td>
<td>31.5 (22.9-38.4)</td>
</tr>
<tr>
<td>Linoleic</td>
<td>2.9 ± 0.46</td>
<td>1.6 (1.0-1.9)</td>
</tr>
<tr>
<td>Linolenic</td>
<td>0.9 ± 0.40</td>
<td>1.2 (0.8-1.8)</td>
</tr>
<tr>
<td>Arachidonic</td>
<td>0.2 ± 0.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>
shown to be neutral in human cholesterolemia (Fidanza, 1982). The non saturated fat acids, and particularly the lynoleic, are in larger quantities. Gigli et al. (1979) have described that the percentage of lynoleic acid increases with age.

The content of protides and the pH are almost similar in bovine and buffalo meat (Girolami et al., 1975; Barone et al., 1982) although there are Authors that have described buffalo meat as richer in humidity and poorer in proteins. The contradiction is explained by the fact that most works have been done on animals of different ages and on different muscles.

As of protein quality we can notice that the aminoacid content of buffalo meat is only slightly different from that of bovine's. In both species the content of lysine is remarkably high and the level of sulphured aminoacids is optimal, facts that can improve diets mainly based on vegetables.

In longissimus dorsi muscles of buffaloes grown in Rumania and slaughtered at a mean weight of kg 356, Creta et al. (1980) have described a mean concentration of collagens of 444 mg % and hydroxyprolilne of 61.25 mg %, with a ratio of total proteins of 23.98 gr % and triptophan of 204.22 mg %.

An appreciable amount of iron is dosable in buffalo meat, quite poor that of calcium as observed also in bovines. The content of vitamins is basically similar to that of "Bos Taurus" and "Bubalus Bubalis". In the latter there is a smaller amount of riboflavin, but Vit. B6 and Vit.B12 are significantly higher (Ferrara et al., 1969).

Quite important are the results obtained by the Institute for Animal Production in Portici and the Experimental Zootechnic Institute of Rome, on the microrheologic characteristics and other chemical qualities of buffalo meat (Matassino et al., 1976; Cosentino et al., 1976). The rheologic data were determined on meat samples with a machine called "Texturometer" that simulates human mastication. In a comparative study with bovine Frisone race, the Authors have found that buffalo veals of 20 months of age give a better meat, more tender, less chewy and requiring less mastication and with a good water retention power. The histochemical individuality of the muscle was also ascertained. Overall the buffaloes gives a carcass with more uniformed rheologic characteristics. With spectro photometric methodologies: in many muscles brilliance, visual luminosity, dominant wave length as an indicator of the color tonality were determined. For all the above the buffalo meat resulted with a neutral component in a higher proportion in all different cuts, which practically means a larger appeal at consumers level.

Later works on older animals (28 and 26 weeks) about the same microrheologic and physical and chemical characteristics (Grasso et al., 1982; Cosentino et al., 1982) have again confirmed the excellent quality of buffalo meat.

Borghese et al. (1978) in other comparative works have observed that the mean percentage of proteins non digested by pepsine is of 1.77% in bovines and 1.74% in buffaloes, with no significant difference. On the average one gram of liophilized buffalo meat contains 0.669 mg of hydroxyproline and 0.907 mg in bovines, with a difference highly significant (P ≤ 0.001). This confirms our opinion and that of other scholars on the better tenderness of buffalo meat. Color and weight structure of the taste triangle, the texture, the meats, in and by cut ted in A steak was Acc to that of the steaks of months of the meat of Johnson.
and weight reduction after cooking resulted similar: therefore the physical structure of the meat is dependent more on the animal diet than on genetics. During taste trials conducted with two different cooking methods and statistically treated, the judges have found no substantial organoleptic difference between the two meats, in agreement with results precedently described by us (Ferrara et al., 1964) and by others (Natl. Acad. Press, Washington, D.C., 1981) about similar trials conducted in Australia, Malaysia, Venezuela and Trinitad. Often, actually the buffalo steak was considered better than the bovine's.

According to Joksimovic (1979) buffalo meat retains a better tenderness than that of bovines at comparable ages, mainly because of a slower growth of the muscle fibres diameters, and for a softer texture of the connective. Samples of 16 months old buffaloes offered the same resistance to the butcher's knife than the meat of 12 months old bovines of Angus, Hereford and Frisone races (Charles and Johnson, 1975).

The recent contributions of Cortesi and Vaccaro (1981) have shown that there are no differences between buffalo and bovine meats in regards to their refrigeration. Actually buffalo meat shows a better hydric retention capacity. When adequate vacuum is reached, buffalo can be preserved up to 60 days at a temperature constantly set at 0 degrees Celsius. Cuts that have bones are less preservable. In those places where the swamp buffaloes are more, most production is becoming a larger source of income. Typical is the case of Australia, where buffaloes are kept semicaptive, that exports buffalo meat principally to Far East countries. A steady export of slaughter buffaloes is made from India and Pakistan to the Middle East. The demand of buffalo is so high that in Thailand, for example, the stocks of such animals has decreased of about 20% (from 7 to 5.7 millions) in about 20 years, during which the human population of the country has doubled (Natl. Acad. Press, Washington, D.C., 1981).

In Trinitad, after many genetic crossings among various buffalo races (Murrah, Surti, Jaffrabadi, Nili and Badawari) a new type of buffalo, called "Buffalypso" was obtained with a particular aptitude to meat production. The animal is tough, with a brown mantle, rustic and with a fast growth. Males at age one year are above 800 lbs and females above 770 lbs. They are already being exported to Colombia and Venezuela, as reported by Bennet (1974). Bastogi et al. (1978) believe that in Buffalypso mean daily gains of a kg are obtainable. The meat of young subjects is well colored, tender and not easily distinguishable from that of first choice bovine cuts. By crossing Buffalypsoes with copper red mantles 25% of offspring presents speckled or albino mantles, considered a defect, which denotes the persistence of heterozygosis. Most recently also in China (Liu Cheng Hwa and Chang Shun Hsun, 1982) have been working to improve meat production in buffalo species by crossing local races with Indian ones, such as Murrah and Nili-Rawi.

CONCLUSIONS

The results obtained by different researchers in particular situations are remarkably different among them because of the studied type (Mediterranean, River, Swamp and corses), the breeds (Murrah, Surti, Nili-Rawi and other), the
sex, age and number of controlled animals, food, feeding and the environments.

Although this great number of data are not directly comparable, yet we can make a few statements.
-- Extraordinary adaptability of the species to new and even very hard environments.
-- Surprising adaptability to new and rational breeding techniques.
-- Immediate and abundant productive response in amounts of milk and meat to the improvement of feeding.
-- Exceptional capacity of utilizing numerous farming, industry and breeding byproducts.
-- Possibility of milking the buffalo cows also without their calves presence, which can yield to very high profits.
-- The calf can be weaned even when nourished with cow milk or dehydrated milk.
-- With good management and a correct food ratio to the pregnant animal, the average birth weight of calves easily reaches 42-45 kg versus the actual average of less than 35 kg.
-- The calf, like the bovine one, can double its birth weight in 48 days (B. Majmone et al., 1941; Bernhart, 1961).
-- Premature weaning does not affect the subsequent growth rate (B. Ferrara et al., 1970; Reafat et al., 1971) but it cannot be started before 40 days of age because until this time the calf does not accept solid food (B. Ferrara et al., 1970).
-- The weight at birth and at 3.5 and 12 months, significantly influenced by the season and the heritability, is, respectively: 0.16±0.07; 0.35±0.17; 0.22±0.16, and 0.13±0.13 (Basu and Rao, 1979).
-- The monthly gain, increases in the first three months, tends to diminish in the 4th month and to stop in the 5th; it increases again in the 6th month (Balasubramanja et al., 1976) and remains constant all along the 15th month. There is, then, a sudden decline from 18 to 30 months to less than 50% and from 30 to 40 months to less than 80% of weight gain (N. Ferrara et al., 1972; L. Minieri et al., 1972; F. Intrieri et al., 1972; T. Di Lella et al., 1972).
-- The more convenient age for calves slaughtering is 14-16 months because until this age the growing rate is excellent (Romita et al., 1982).

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