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EFFECT OF REARING PRACTICES ON THE WATER CONSUMPTION BY PIGLETS IN THE FIRST EIGHT WEEKS AFTER BIRTH

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Abstract

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Water consumption was assessed in two groups of piglets during the first 8 weeks after birth. Group 1 consisted of litters suckled by the sows and receiving supplementary feeding from the 3rd week after birth. Piglets of Group 2 were reared in isolation in a thermoneutral zone from the 2nd day after birth on a 78.47 % hydrated diet that was offered to them for sucking at first ten times a day and after 4 weeks nine times a day at 2-h intervals.

With advancing age the piglets increased their water consumption mainly in dependence upon the ingestion of energy: the traditionally-reared piglets, from 0.44 (in the 1st week) to 1.60 kg . d^{-1} (in the 8th week) and the early-weaned piglets, from 0.37 to 3.52 kg . d^{-1} during the same period. The latter began to differentiate from Group 1 animals by a larger water intake in the 3rd week.

The relatively highest daily water consumption per live body mass was shown by Group 1 animals in the 2nd week (23.3 %) and by Group 2 animals in the 3rd and 4th week (27.4 and 26.5 % of live body mass, respectively). Afterwards their water consumption gradually decreased, declining to about one half of the peak value of the 8th week. Related to metabolic mass, the water consumption was even higher. In traditionally-reared piglets it reached the peak, 28.8 %, in the 2nd week. In early-weaned piglets it rose from the initial value of 24.9 to 43.2 % in the 5th week, then declined rapidly, but still accounted for 34.0 % in the 8th week.

It is concluded that both traditionally-reared piglets and early-weaned piglets, in particular, show high, mainly prandially-determined water ingestion particularly in the 1st postnatal month, when it is two and a half times higher than characteristic of grown-up pigs.

Nutrition, milk, supplementary feeding, liquid diet, early weaning

Daily water ingestion by pigs weighing 15 to 90 kg has been reported to rise from 1 to 5 kg, being affected by environmental temperature (Mount et al. 1971) and reaching 100 g per kg live body mass in the zone of temperature comfort (Mount 1968; Mount and Ingram 1971). Accordingly, it should be relatively highest in the youngest piglets. These, however, ingest water in a different way than grown-up pigs. Suckled by the sow, piglets developed a rigid nutritional stereotype divided into three to five phases, recurring at about 1-h intervals, soon after birth. They suck milk under active participation of the sow only during one phase lasting merely 13 to 37 s (Barber et al. 1955; Gill and Thompson 1956; Whittemore and Frazer 1974; Newberry and Wood-Gush 1985; Holub 1988; Jensen 1988). From 3 to 5 days of age, however, they not only suck water in milk but also drink it from watering installations (Groth 1980) similarly to grown-up pigs. At the same time they begin to be able to consume also non-liquid food which, however, is generally not offered to them until the 3rd week after birth (Holub 1962). Under such rearing practices their total water intake increases from 481 (in the 1st week) to 1 729 g . d^{-1} (in the 8th week) (Aumaitre 1964, 1965). However, the consumption of free water

by drinking is lower (Bauer et al. 1978; Wójcik et al. 1978; Bauer 1983, Fraser et al. 1988).

However, piglets can be reared even when the complex biological unit, the sow and her litter, is broken up. For example, soon after birth they can be weaned onto a liquid diet, similar in its macronutrient content to sows' milk, offered to them for sucking at regular intervals (Holub 1963, 1964, 1966, 1982, 1988; Holub and Komárek 1964). In this way they are deprived of the possibility of choosing the frequency of consumption and of combining milk sucking with the intake of non-liquid supplement and with water drinking; in other words they cannot choose the kind of food and can decide only about the sucking style and the size of the meal (Holub 1988). In cases of weaning on the 2nd postnatal day they consume, after a short adaptation period, 150 to 160 g water per kg live body mass per day (Ponížilová and Holub 1964).

Up to now, sufficient detailed data are not available on water intake by piglets during the intricate postnatal period particularly after their sudden transfer from the ritual collective nutrition with competitive elements to the solitary nutrition of completely isolated animals.

Materials and Methods

One group of piglets (Group 1) was reared traditionally; they were suckled by the sow, and supplemented with feed grain, potato flakes, protein mixture, skim-milk and green fodder from the 3rd to the 8th week after birth. Their water consumption was extrapolated from the data on milk and supplementary food consumption by 102 Large White piglets of ten litters that were weighed before and after ingestion (Navrátil 1958, 1959; Trávníček 1960; ČSN 46 7007 1966). The procedure was decribed and discussed in detail in previous communications (Holub 1963, 1968, 1988).

Another group of 57 Large White piglets (Group 2) was transferred to cages and reared individually in temperature comfort as described previously (Holub 1964, 1966, 1988; Holub and Komárek 1964). They were fed a liquid diet heated to body temperature and offered to them for sucking ad libitum from feeding bottles ten times a day in the first 4 weeks and nine times a day in the following weeks at 2-h intervals except a night break of 6 or 8 hours. Its consumption was measured by weighing the bottles before and after sucking. The diet contained 78.47 % water, 4.95 % crude protein, 6.78 % lipids, 8.59 % saccharides and 5.36 MJ . kg^{-1} brutto energy (BE); its water content was therefore 146 g . MJ^{-1} BE and 16 g . g^{-1} protein. Live body mass of the piglets was checked daily before the first sucking.

The significance of the results was assessed by Student's t-test and their variability was expressed in terms of standard errors of the means.

Results

Total Water Intake

Piglets suckled by the sows and gradually supplemented consumed 57.81 kg water during 56 days, i. e. an average of 1.03 kg per day. However, in the 1st week it was only 0.44 and in the 8th week as much as 1.60 kg . d^{-1}. At first the only source of water was milk, accounting for 0.71 in the 2nd week but for as little as 0.36 kg . d^{-1} in the 8th week. From the 2nd to the 8th week the amount of water sucked through milk declined to one half, whereas the amount of water received with supplementary feed showed an abrupt increase, rising from 0.01 in the 3rd week to as much as 1.24 kg . d^{-1} in the 8th week. Consequently, the contribution of non-milk nutrition to total water consumption accounted for more than one half in the 5th week and exceeded that of milk nutrition more than three times in the 8th week.

Early-weaned piglets consumed 106.19 kg water during 56 days. Of this the proportion consumed through liquid diet was 105.82 kg water, i. e. an average of 1.92 kg per day. In the 1st week it was only 0.37 and in the 8th week 3.52 kg.d^{-1}.

Thus the water intake between the 1st and 8th weeks after birth increased in both traditionally-reared and early-weaned piglets, though not at an equal rate: it rose three and a half times in the former and six and a half times in the latter (Fig. 1).

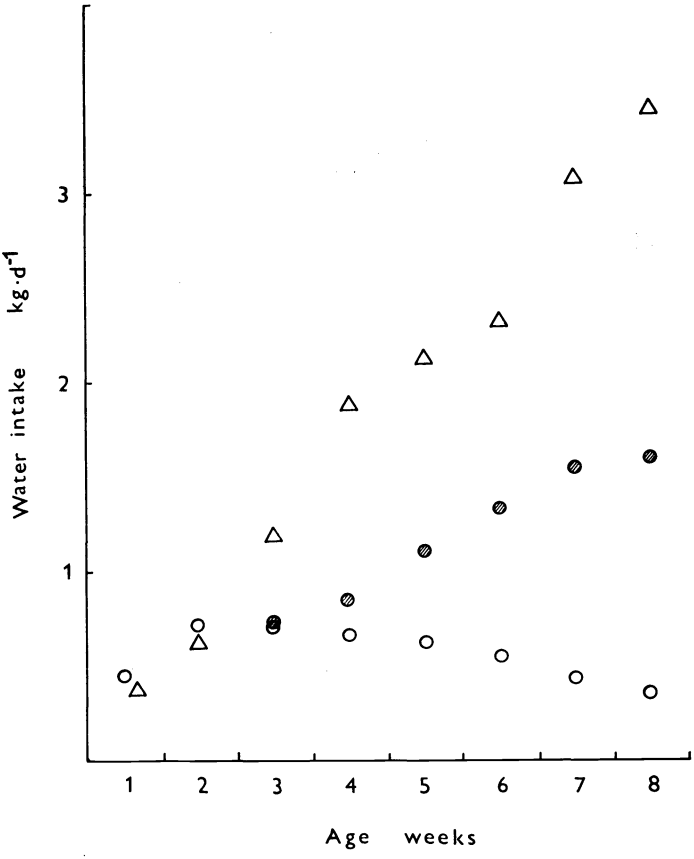

Fig. 1. Daily water consumption of traditionally-reared and early-weaned piglets in the first 8 weeks after birth. Piglets on sows: water in milk ○, water in milk and creep ●; early weaned piglets: water in diet △.

Water Intake, Live Body Mass and Gains

Piglets left with the sows increased their live body mass from 1.39 on day 1 to 14.71 kg on day 56, i. e. by 13.32 kg, and early-weaned piglets, from 1.54 on day 2 to 25.68 kg on day 56, i. e. by 24.14 kg.

Water consumption per kg body mass gain in the two groups was almost the same: 4.34 and 4.38 kg. In Group 1 it was 2.38 in the 1st week and 4.71 and 4.65 kg in the 5th and the 7th week, respectively; in Group 2 it was 2.92 in the 1st week and 7.30 kg in the 8th week. Thus it increased twice in piglets left with the sows and rose to twice and a half the initial value in early-weaned piglets where its level was higher in general.

The relation of daily water consumption to body size developed as follows: In Group 1 it was 20.0 % in the 1st week, peaked to 23.3 % in the 2nd week, declined to 13.7 % of live body mass in the following 2 weeks and showed little change afterwards. In Group 2 it was consistently higher: it was 21.8 % in the 1st week, 27.4 and 26.5 % in the 3rd and the 4th week, respectively, then declined to 16.7.% of live body mass during the following week and showed little fluctuation thereafter (Fig. 2).

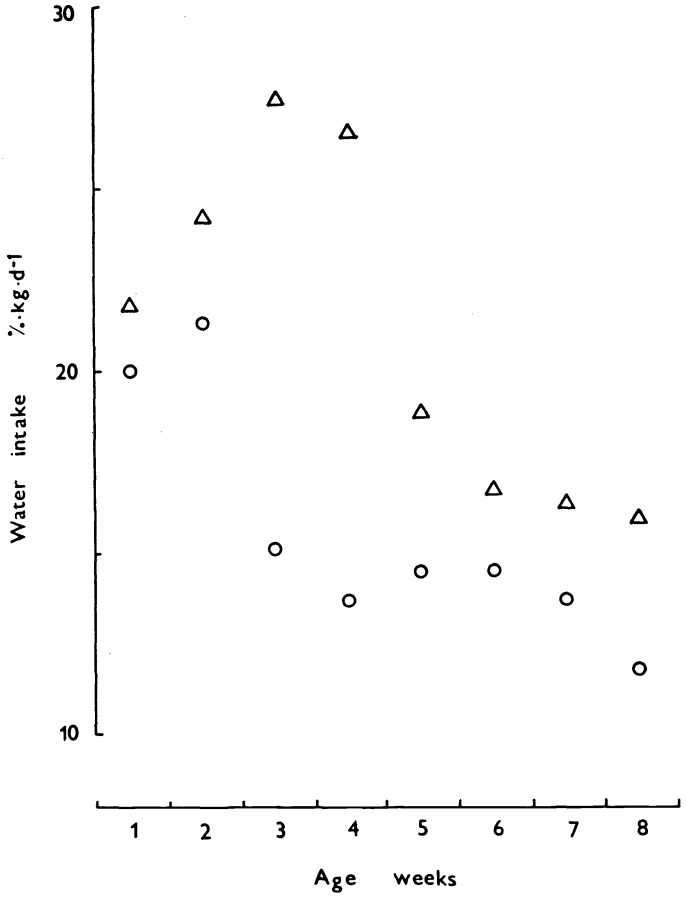

Fig. 2. Daily water consumption of piglets per body mass in the first 8 weeks after birth. Piglets on sows ○, early weaned piglets △.

Water consumption per metabolic mass (kg $^{0.75}$) was substantially less age-dependent in Group 1: it ranged between 28. 8 (in the 2nd week) and 21.6 % (in the 8th week). In Group 2 it was higher: it rose from 24.9 in the 1st week to 43.2 % in the 5th week, then declined abruptly to 34.0 % and showed little change thereafter (Fig. 3).

Water Intake and Energy and Protein Consumption

In traditionally-reared piglets the ratio of water intake to BE consumption ranged between 155 in the 1st week and 186 g . MJ^{-1} in the 5th week and that to crude protein consumption between 13 in the 1st week and 17 g . g^{-1} in the 2nd week. In early-weaned piglets these relations showed no variation.

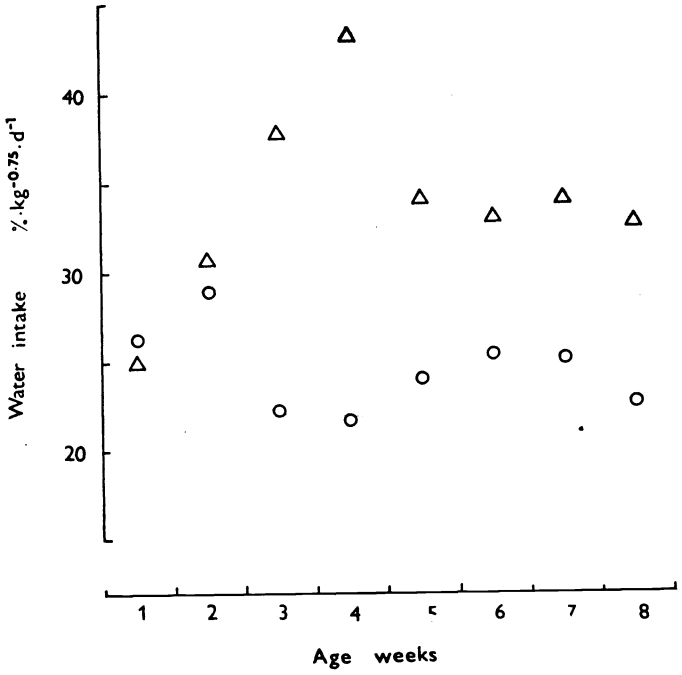

Fig. 3. Daily water consumption of piglets per metabolic body mass in the first 8 weeks after birth. Piglets on sows ○, early weaned piglets △.

Discussion

Water consumption is activated by dehydration and hyperosmia. It is a manifestation of water deficiency in the body and its interpretation would lose physiological value without taking this fact into consideration. Therefore it is generally related to various functional determinants.

One of them is body size. In grown-up mammals water metabolism and therefore also water intake have been associated with the exponent of their live body mass, $kg^{0.88}$ (Adolph 1949) or $kg^{0.9}$ (Chew 1965). In our experiments, however, this was not the case. The relation of water consumption to live body mass changed with age: at first it rose and then decreased markedly to only one half of its peak value. Not even to another generally used physiological parameter, metabolic mass, was water consumption directly proportional according to our measurements.

According to other writers daily water consumption by pigs equals one tenth of their live body mass (Mount 1968; Mount and Ingram 1971). In both groups of our pigs, however, it was consistently higher, and more than twice as high in the first two weeks. In Group 1 it fell abruptly afterwards but still exceeded one tenth of their live body mass up to the 8th week. In Group 2 it not only remained high in the 3rd and the 4th week but rose even further, amounting to twice and a half the original value, and although it also decreased subsequently, in the 8th week it was still higher than in Group 1 (Fig. 2). Also the formula assuming the existence of a non-linear relation between body mass and water ingestion in piglets of various ages (Aumaitre 1964, 1965) fails to correspond to our data with reasonable accuracy.

Water consumption is also determined prandially; it interferes with food intake. Feeder pigs consume 2.2 to 2.5 l drinking water per kg dry feed (Braude 1967). This generally cited observation has recently been specified to 2.14 ± 0.46 l, considering that the changes are due mainly to the fluctuations in water consumption and not in feed consumption. This prandial relationship is, no doubt, associated with the fact that as soon as pigs reach 10 kg in body mass, they drink three quarters of their water intake at feed consumption (Bigelow and Houpt 1988).

Water consumption from drinking installations by traditionally-reared piglets cannot be related merely to their hydration needs. In fact, it is conditioned by the physiological status of the higher biological unit, litter plus sow, and by its lactation. In consequence, piglets receiving more nutrients and water by sucking (thus having also larger gains in body mass) consume less water by drinking (Fraser et al. 1988) than equally old piglets suckled by less lactating sows.

From the above-mentioned considerations it appears that water intake must be also a function of the consumption of macronutrients, BE and protein. Their relation in our experimental group of traditionally-reared piglets showed only moderate variation. The fluctuations observed may have been due not only to changes in the chemical composition of sows milk and its decreasing contribution to the nutrition but also to functional maturation of the piglets, particularly to that of their gastrointestinal tract. As a matter of fact, the period that was the subject of our interest is one during which piglets pass through a complicated functional development (Holub 1968, 1982, 1988). Their drink and food after birth is milk which they suck collectively in a remarkably complex and rigid ritual under active participation of the sow (Frazer 1980; Algers and Jensen 1985), thus covering their hydration, nutritional and other needs. The mechanisms underlying water consumption of mammals during this phase of development are not so complex as in grown-up animals (Adolph 1968; Phifer and Hall 1988). In piglets the transition from the early regulation to a more mature and more plastic one does not occur until the weaning period (Holub 1968, 1988) during which piglets not only suck but also drink. A new hierarchy of the regulation comes then into operation under which more specialized integrated hydration responses become possible. In traditionally-reared piglets the entry into this phase of nutritional regulation occurred mainly in the third postnatal week. The contribution of water received in variously hydrated components of the supplementary feeding increases to as much as four fifths by the end of the 8th week.

A different situation exists in piglets sucking a liquid diet of a steady water, energy and protein content throughout the experimental period. They can neither select the kind of food nor change the frequency of its intake (Holub 1988). The consequences of such an intervention into their lives have been discussed previously (Holub 1964, 1966, 1988; Holub and Komárek 1964). In the first two weeks after birth the consumption of energy is remarkably high, amounting to 2.77 MJ . . $kg^{-0.75}$. d^{-1} BE, in both traditionally-reared and early-weaned piglets. In the former it then declines. In early-weaned piglets, however, it continues to rise for another two weeks and, although it also falls afterwards, it continues at a significantly higher level than in traditionally-reared piglets throughout the observation period (Holub 1964 1966, 1988; Holub and Komárek 1964). Therefore the water consumption of these piglets is also high.

Another possible factor adding to the high water consumption of these piglets may be their somatic inequality at birth. Although the criteria of maturation re-

quire further specification, it can be presumed that some piglets in the litter show signs of developmental retardation (Holub, unpublished data) and, like immature human neonates, are characterized by a higher rate of water metabolism (MacLennan et al. 1983).

Vliv technologie odchovu na konzum vody u selat v prvních osmi týdnech postnatálního života

U dvou skupin selat jsme po osm týdnů určovali konzum vody. Jedinci skupiny první byli odchováváni ve vrzích u prasnic, byli kojeni a od třetího týdne přikrmováni. Jedinci druhé skupiny byli od druhého dne po narození odchováváni izolovaně v termoneutrální zóně na dietě hydratované ze 78,47 %, jež jim byla nabízena k sání zprvu desetkrát a po čtyřech týdnech devětkrát denně ve dvouhodinových intervalech.

S přibývajícím věkem selata konzum vody zvyšovala především v závislosti na ingesci energie; pod prasnicemi z 0,44 (v týdnu prvním) na 1,60 kg . d^{-1} (v týdnu osmém) a raně odstavená (v téže době) z 0,37 na 3,52 kg . d^{-1}. Druhá skupina se počala od první lišit větším příjmem vody ve třetím týdnu.

Relativně nejvyšší denní konzum vody na živou hmotnost jevila selata první skupiny v týdnu druhém (23,3 %) a druhé ve třetím a čtvrtém (27,4 a 26,5 % živé hmotnosti). Poté jej postupně do osmého týdne snižovala na zhruba polovinu maxima. Na metabolickou hmotnost jej měla ještě větší. U selat pod prasnicemi dosahoval v týdnu druhém, kdy byl maximální, 28,8 %. U selat odstavených druhého dne stoupal z počátečních 24,9 do pátého týdne na 43,2 %. Pak rychle poklesl, ale ještě v týdnu osmém činil 34,0 %.

Z uvedeného vyplývá, že jak selata odchovávaná pod prasnicemi, tak, a to zvlášť, raně odstavená vykazují především v prvním měsíci života vysokou, hlavně prandiálně determinovanou ingesci vody, relativně až dvaapůlkrát větší než prasata vzrostlá.

Влияние технологии содержания на потребление воды поросят в первые восемь недель постнатальной жизни

У двух групп поросят в течение восьми недель определяли потребление воды. Особи первой группы содержались в племенном гнезде около свиноматок, питались молоком и, начиная с третьей недели, прикармливались. Особи второй группы начиная вторым постнатальным днем содержались изолированно в термонейтральной зоне на гидратированной диете из 78,47 %, предоставляемой им сперва десять раз и спустя четыре недели девять раз в сутки в двухчасовых интервалах.

С возрастом потребление воды поросятами увеличивалось прежде всего в зависимости от объема энергии - под свиноматками из 0,44 (на первой неделе) до 1,60 кг в сутки (на восьмой неделе) и у ранних отъемышей (в то же время) из 0,37 до 3,52 кг в сутки. Вторая группа от первой стала отличаться большим потреблением воды на третьей неделе.

Относительно самое большое суточное потребление в пересчете на живую массу наблюдалось у поросят первой группы на второй неделе (23,3 %) и второе на третьей и четвертой неделе (27,4 и 26,5 % живой

массы). После этого до восьмой недели потребление постепенно понижалось приблизительно до половоны максимума. В переводе на метаболическую массу потребление было еще больше. У поросят под свиноматками максимум наблюдалось на втрой неделе - 28,8 %. У отъемных поросят со второго дня увеличивалось потребление воды с первоначальных 24,9 до пятой недели до 43,2 %. После этого наблюдается стремительное понижение, однако еще на восьмой неделе достигает 34,0 %.

Из сказанного вытекает, что содержащиеся под свиноматками поросята и поросята, содержимые отдельно, ранние отъемыши, отличаются прежде всего на первом месяце жизни высоким, главным образом прандиально определенным потреблением воды, приблизительно в два с половиной раза больше чем у взрослых особей.

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