Monitoring of the individual drinking behavior of healthy weaned piglets and pregnant sows

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Abstract
Trials were conducted on the experimental station of Ifip in Romillé (Brittany, France) to assess the individual dinking behavior of healthy weaned piglets and pregnant sows. To collect this type of data, a specific connected drinker has been developed. It is composed of an antiwastage bowl drinker surrounded by shoulder partitions, a precision water meter (± 0.01 l for piglets and ± 0.1 l for sows) and a RFID (Radio Frequency IDentification) antenna to detect animals near the drinker thanks to the electronic and individual ear tag on each pig. Observations on animals have been made twice a week to evaluate their health status. This study only focuses on healthy animals. Weaned piglets were bred in pens of 19 animals. On average, the individual water consumption was 10.7% of body weight. Sows were bred in a dynamic group equipped with 6 connected drinkers and automatic feeders. On average, the daily water consumption was 8.2l/day (1.6l during the meal and 6.6l directly to bowl drinker). For the two types of animal, it exists an important inter and intra individual variability on the water consumption (more than 30%). Thus, working only on the health status of piglets or sows only thanks to the drinking behavior seems to be difficult. The next step is to cross this information with other data (feeding system, automatic weighing station, accelerometer…) to determine a behavioral pattern of healthy animals.

Keywords
Drinking behavior, connected drinker, water consumption, pig, monitoring, healthy

Introduction

Drinking behavior and water consumption of pigs seem to be an interesting indicator to well understand their health status. Indeed, several authors found that an animal can modify its feeding and/or drinking behavior during the onset of diseases (Pijpers *et al.*, 1991 ; Andersen *et al.*, 2014). This modification may appear few hours before the beginning of the first clinical symptoms observed by an operator (Madsen and Kirstensen, 2005 ; Brumm, 2006).
Such an early prediction of disease can be an innovative way to decrease antibiotics consumption, by treating quicker sick animals in order to reduce the transmission of pathogens to others or by treating only sick animals instead of all the group. To be more effective in this potential early prediction of disease, it’s essential to collect individual data because collective drinking behavior can hide an important variability.
Thus, one of the goals of this study is to develop and validate a technology able to record the individual drinking behavior of weaned piglets or pregnant sows. It will be used to determine the water consumption patterns of healthy pigs.

Material and methods

Periods of trails

Trial for weaned piglets was implemented from the 4th June to the 16th July 2015. First days of trial have been used to design and to test connected drinkers, that's why the results only concerned the 22 last days of post weaning (from the 47th to the 69th day of age). Trial for sows was implemented during 58 days, from the 4th May 2016 to the 30th June 2016.

Connected bowl drinker

An automat has been developed with a French firm specialize in animal livestock housing (Asserva) in order to isolate and identify pigs in front of the drinker then to record their individual drinking behavior. This automate called Aqualab is composed of an antiwastage bowl drinker surrounded by shoulder partitions, a precision water meter (± 0.01 l for piglets and ± 0.1 l for sows) and a RFID (Radio Frequency IDentification) antenna to detect animals near the drinker thanks to the electronic and individual ear tag of each pig (Figures 1 and 2). This automat is connected to a computer which records water quantity used and duration of each visit. The amount of water recorded includes real consumption of pig and water wastage, this last being considered like a part of the natural drinking behavior of pig.

Figure 1: Connected drinker for pregnant sow

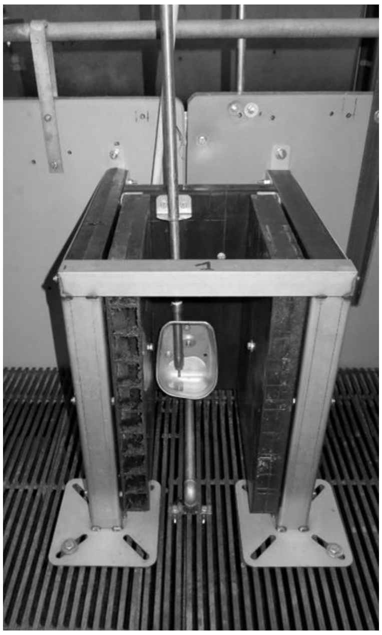

Figure 2: Connected drinker for piglet

Housing conditions

Tests have been made in Ifip experimental station in Romillé (Brittany, France).

- Weaned piglets: After weaning, 228 piglets, 28 days old, were allocated in 12 pens of 19 animals: Three weight groups were created with four pens each (heavy, medium and light with respectively a mean weight of 11.1 kg, 9.1 kg and 7.0 kg). Piglets were individually weighed every 14 days. As shows on Figure 3, six pens had one traditional bowl drinkers and the others had one connected drinker (Aqualab). The water flow was adjusted to 1 l/minute and it was checked every

14 days. The daily water consumption of the twelve pens was recorded. Pens were warmed at 28°C at the beginning of post-weaning and temperature dropped progressively to obtain 24°C at the end of the trial.

- Pregnant sows: 83 sows (3 different batches on 3 different gestation periods) were bred in a dynamic group. They were fed individually with automatic feeders thanks to their electronic ear tags. They were given dry food but some water (0.5 liter / kilogram of feed) was automatically added inside trough for the needs of the capacitive sensor that detects the remaining level of food. Sows were weighted every day with an automatic weighing station located on feeders' exits. Six connected drinkers were installed (Figure 4). The water flow was adjusted to 3 l/minute and it was checked every 14 days. The pen's temperature was maintained around 21 °C during all the trial.

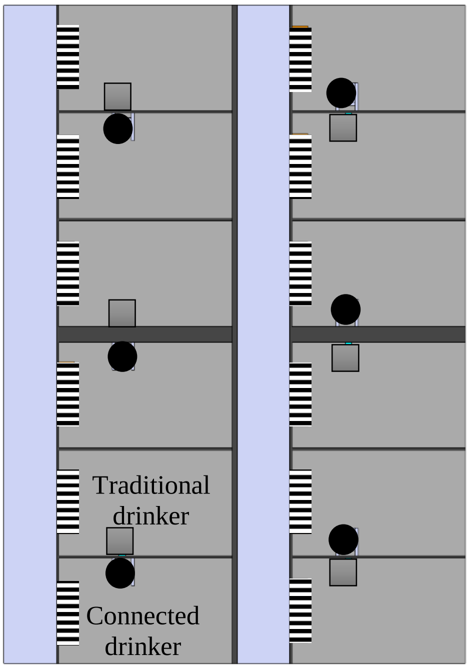

Figure 3: Housing conditions of piglets (black horizontal lines for feeding system, circle for connected drinker and scare for traditional drinker)

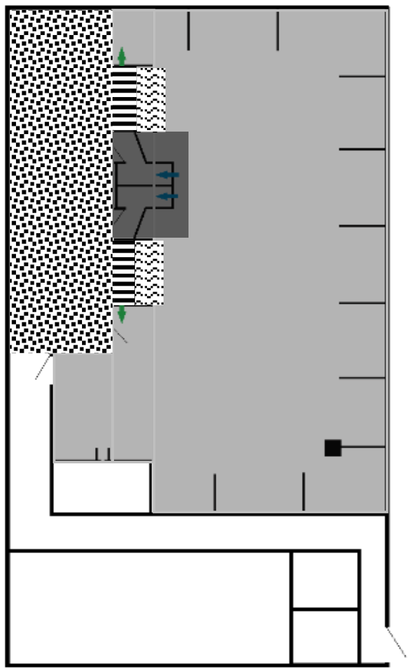

Figure 4: Housing conditions of sows (grey for life area, dot for selected area, black wave for connected drinker, black for automatic feeder and black horizontal lines for weighing station)

Animal's health status

Each day, animals were observed by the staff of the station to assess their health status. A specific focus has been done on the most frequently diseases observed in pig barns: locomotor and urinary disorders for sows and digestive and respiratory disorders for piglets. In addition, observations on the general health status were done by an external operator on each animal once a week for sows and twice a week for piglets. This evaluation was based on a rating grid inspired by the Welfare Quality approach. All remarks relating to the health were recorded (pathology, severity, date, operator, veterinary intervention if necessary). For sows, individual urine test strips were made at the end of their pregnancy.

Statistical analyses

The data analysis by descriptive statistics was carried out under R version 3.3.1. The comparison of water consumption between pens according to their drinker type (traditional bowl drinker vs connected drinker) was carried out using a non-parametric test (Kruskal-Wallis).

Results

All the results concerned only animals observed healthy. Data of sick animals were deleted from the database: (i) for locomotor, digestive or respiratory disorders; we kept the animal in the database but we suppressed all the data around the day concerned (ii) for urinary disorder; we suppressed all the data of the animal.

Weaned piglets

At the end of the trial, the data of 95 animals (on 114) are kept. On 22 days, the average water consumption does not differ significantly according to drinking equipment (traditional bowl drinker vs connected drinker). Therefore, the automat does not seem to interfere with piglets' access to drinker.

Daily individual water consumption of piglets is, on average for all animals, of 10.7% of body weight in kilograms (BW). Table 1 shows great inter-individual variability since the coefficient of variation (CV) calculated from the average of the individual average values obtained per piglet is 33.6%. On intra-individual scale, the daily consumption expressed per kilogram of BW is also very variable, the coefficient of variation of the individual measurements being on average 31.5% (± 9.9).

Table 1 : Mean and variability of the daily water consumption of weaned piglets

Scale	Parameters	Values
Inter-individual	Average, l/kg of body weight (BW) Standard deviation Coefficient of variation (CV), %	0.104 0.035 33.6
Intra-individual	Average CV, % Standard deviation of CV	31.5 9.9

With connected drinker, it is possible to follow the daily water consumption of each piglet on several days. As an example, Figure 5 shows the individual consumption profiles of three piglets compared to the average profile obtained from 95 piglets.

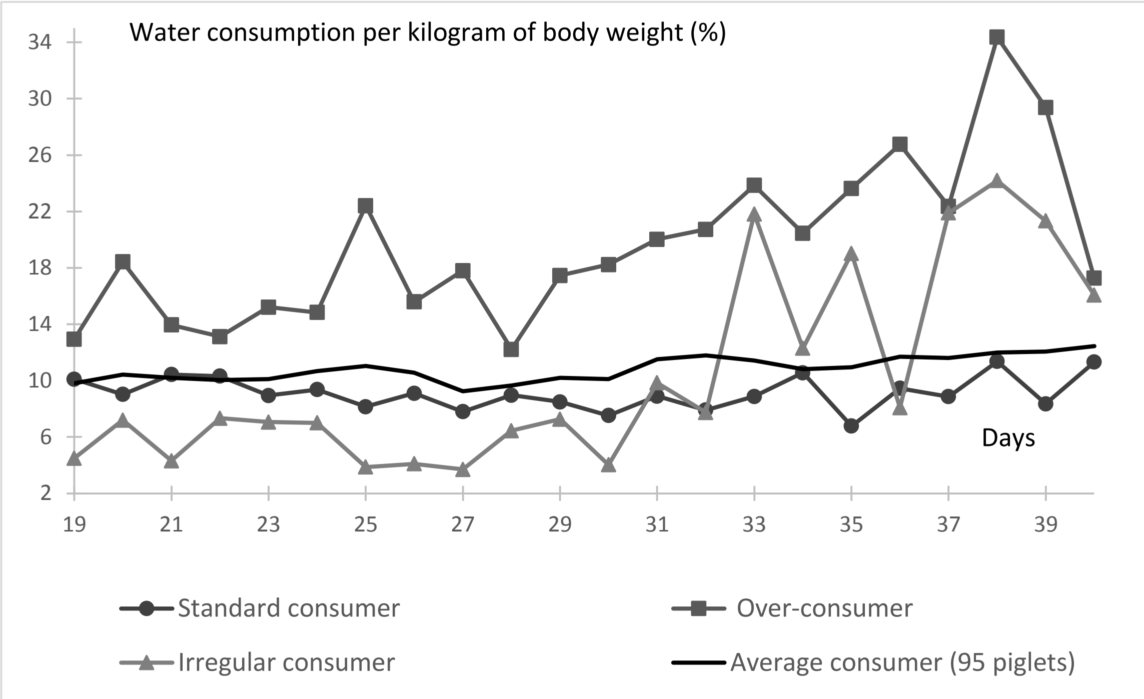

Figure 5: Contrasted examples of drinking behavior of weaned piglets

- The profile named "Standard Consumer" matches with a piglet consuming a quantity of water between 7 and 11% of BW. Its profile is regular and relatively close to the consumption profile of the average piglet.
- The profile named "Irregular Consumer" matches with a piglet whose consumption of water from one day to the next can be very different (variation of 13.8 % of BW between the 36^{th} (8.1 % BW) and 37^{th} day (21.9 % BW)).
- The profile named "Over-consumer" corresponds to a consumption greater than the average consumption of the average piglet. It varies from 13 to 34% of BW.

Most of the remaining 92 piglets do not have such specific and contrasting profiles as these three examples: they pass from one to the other over time, which is even more difficult to interpret and to predict.

It also exists an important variability on the drinking behavior of piglets. At each visit, the average amount of water consumed per piglet was 104 ml (SD 133). The number of visit to the drinker is around 27.2 (SD 12.3) per day.

<u>Pregnant sows</u>

At the end of the trial, the database was composed of 4814 data (1 data is equivalent of the drinking behavior of one sow on one day). We removed the data in relation of locomotors disorders and all the data of two sows: one for an urinary disorder and one for aberrant data. Indeed, we have identified an atypical sow, whose average water consumption was 41.7 l / day, that is to say more than four times the water consumption of the average sow. In addition, it represented 14.8% of the inter-individual variability of daily average water consumption.
The final database is composed of 81 sows and 3 900 data.

On average, sows weighed 252 kg and consumed 8.2 l of water per day, divided into: (i) 1.6 l consumed during the meal (water added in automatic feeder) and (ii) 6.6 l consumed spontaneously at connected drinkers.

On the water consumption, Table 2 shows great variability on two levels. On the one hand, a very important inter-individual variability: the coefficient of variation (CV) calculated from the average of the average values obtained per sow is 50.0%. On the other hand, the intra-individual variability is also significant: the average individual CV on daily water consumption is 37.9% ± 10.2.

Table 2 : Mean and variability of the daily water consumption of pregnant sows

Scale	Parameter	Value
Inter-individual	Average, ml/kg of body weight (BW) Standard deviation Coefficient of variation (CV), %	33,2 16,5 50,0
Intra-individual	Average CV % Standard deviation of CV, %	37,9 10,2

As shows on Figure 6, the litter rank of sows was significantly linked to water consumption. Primiparous had a drinking behavior completely different. Their water consumption was 49.2 ml/kg BW (± 46.9). Older sows (litter rank upper than 6) had a lower consumption than the first group and it was around 18.9 ml/kg BW. It concerned only a small part of the population (8 sows on 81) so some reserve can exist on this result. Sows with a litter rank of 0, 2, 4 and 5 seemed to have the same water consumption and it was around 34.0 ml/kg BW.

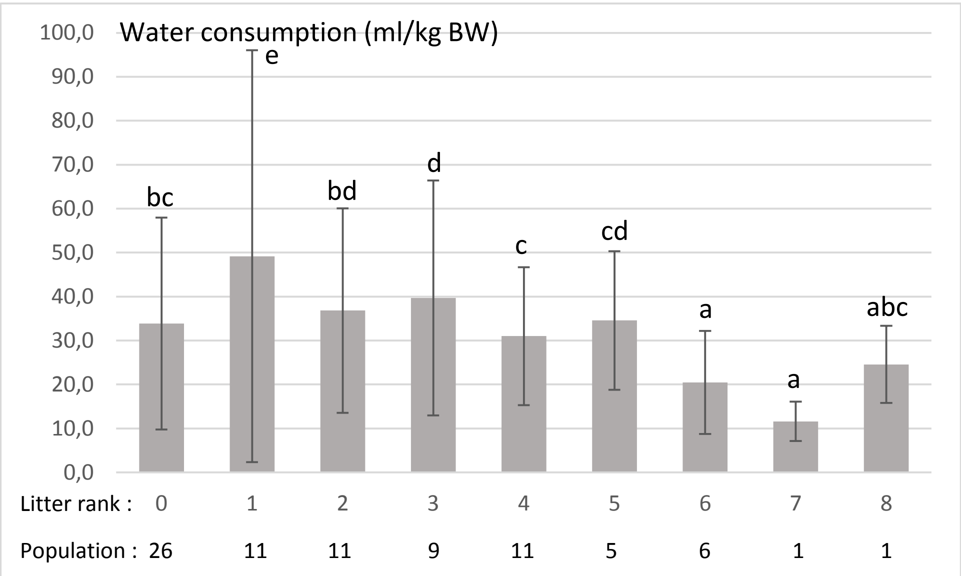

Figure 6: Water consumption and litter rank of pregnant sows.

The batch effect is common with the stage of gestation and it existed significant difference. Sows on the beginning of the gestation (from the 28th to the 85th days of gestation) had a water consumption of 34.9 ml/kg BW. Sows in the middle of gestation (from 41 to 98) consumed around 45.0 ml/kg BW. To finish, sows at the end of gestation (from 62 to 110) consumed around 25.8 ml/kg BW.
These differences are not only due to the litter rank of sows in each batch because we found the same type of results when we studied the interaction between batch and litter rank and it was also significant.

During all the trial, the daily mean temperature of pen stayed around 22.0 °C (±1). Only one day was hotter, with a mean temperature of 26.9 °C. There was no effect of the temperature on water consumption.

There was also no statistical link between water distributed in the feeding system and water consumption probably because the main water consumption is on bowl drinkers.

Discussion

The water consumption observed on weaned piglets (around 10 % of BW) is really close to data already presented in the bibliography (Ward and McKague, 2007). We don't observe an effect of the air ambient temperature but piglets have staying in their thermal comfort zone during all the trial (between 24°C and 28°C).
On sow, we also found no effect of air ambient temperature on water consumption. It will be probably easier to show this effect on the month of July or August.
The global water consumption of sows is relatively close to results of Klopfenstein *et al.* (1996) who found an average water daily consumption between 5 and 9 liters by sow (dry feed and individual trough). Cerneau *et al.* (1997) indicated an individual daily water consumption of 20 liters/sow (group of four animals with soup distribution). With soup distribution, water consumption is generally higher than in dry system because main of the water intake is determined by the soup dilution rate.
Kruse *et al.* (2011) showed, with a connected drinker equivalent to ours, a link between water consumption, litter rank of sows and day of gestation. They worked on water consumption and not on water consumption divided by body weight. Nulliparous sows had the lower consumption (around 12 liters/day) and multiparous the higher (around 22 liter/day). This result is probably due to the difference of weight between sows (around 160 kg for nulliparous and 270 kg for multiparous). On working on water consumption divided by body weight, we obtained results less contrasted and water consumption per kilogram of BW seems to be less important for multiparous than for nulliparous. Kruse *et al.* didn't find atypical results for primiparous in contrary to this study where their drinking behavior are really variable.
Kruse *et al.* showed an increase of water intake during the gestation in relation with weight gain of sows. If you take into account this weight gain, water intake per kilogram of BW seems to increase from the beginning to the middle of the gestation and then to decrease.
In the future, it can be interesting to measure water wastage to better understand the water consumption of few sows and eventually interpret this data in relation with ambient air temperature or behavioral disorders.

The study of litter size can also be interesting to understand a part of the variability on sows' water consumption. We can suppose that more the litter size is important, more the physiological water intake of sows is important.

Conclusion

It exists significant inter and intra-individual variabilities on water consumption of healthy weaned piglets and pregnant sows, so it seems to be appropriate to work on an individual scale for studying the link between drinking behavior and the detection of pathologies. The connected drinker can therefore be an interesting solution on this thematic. The next step is to use this data on water consumption of healthy pigs as a reference to understand and interpret variations when pigs begin to be sick. The final goal is to create a tool able to generate relevant alerts in real time in connection with a potential early deterioration in the health status of piglets or sows (diarrhea, hyperthermia, lameness ...) or with problems on the drinking system (water leak, obstruction). The huge variability observed is one of the main issue, so we will probably need to cross water consumption with other data coming from automats or sensors (automatic feeder, automatic weighing station, accelerometers…) to make an efficient alert system in relation with animals' health. Others study are in progress on this way and they could create new opportunities to control the animals' health status.

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