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(54) Title: METHOD AND AN APPARATUS FOR THE DIETARY OPTIMIZATION OF GROWING SWINE		
(57) Abstract		
<p>The method for the dietary optimization of growing swine consists of artificially altering the natural gastric motility of the swine, by means of sequential electrical pulses and for selected periods of time, to prevent or to slow down the emptying of the intestines and therefore to lengthen the gastric time of food and the gastric digestion time, for a more effective intestinal absorption reducing the fodder necessity of the swine without reducing the weight increase of the swine. The process is performed with an electronic apparatus for the dietary optimization of growing swine, including an electrical stimulator arranged under the skin at the sternal ensiform apophysis in a middle position and having means for an electrical connection to the seromuscular layer of the gastric antrum wall.</p>		

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METHOD AND AN APPARATUS FOR THE DIETARY OPTIMIZATION OF
GROWING SWINE

The present invention relates to a method and an apparatus
5 for the dietary optimization of growing swine.

As known, the swine, by genetic, natural or human selection,
is a true food transforming machine.

10 A pig has in fact an exceptional appetite and voracity
which, on one hand produce a high yield of fat and meat,
while on the other hand causes an accelerated alimentary
transit which means a limited capacity of absorption and a
considerable waste of fodder in the form of undigested fecal
15 residue.

Beside the waste of fodder in the undigested residue, the
caloric expense must be considered of a digestive system
which has to perform a difficult digestive process and which
20 has to tolerate an antieconomic suffering and compensatory
hypertrophy.

The above is the consequence of the change of habitat and of
the change of the natural diet induced by man for industrial
25 and economic reasons.

In order to at least partially reduce the considerable
consumption of fodder during the swine growing, several
dietary systems have been tried relating to the fodder
30 composition or to the way of feeding.

However, improving the fodder efficiency sometimes lowers

the quality of the final product both regarding the nutritional quality and the taste.

The aim of the present invention is to optimize the ratio
5 digestion-absorbtion of the swine in order to improve the yield, in lean mass, of the given fodder.

Within this aim, an object of the invention is to devise a method and an apparatus for improving the growing of a swine
10 by improving the efficiency of the digestion-absorbtion process without using pharmaceutical compositions and/or stratagems which may alter the organoleptic qualities of the final product derived by the animal.

A further object of the invention is to devise a method and
15 an apparatus which, given the same weight increase of a swine treated with conventional techniques and of one treated with the present invention, provides a considerable reduction of consumed fodder, a reduction of the fecal undigested residue, a reduction of the visceral growth, an a
20 reduction of the feces volume.

Not least object of the invention is to devise a method and an apparatus which considerably reduce the costs of feeding the swine and of disposing of its organic fluids without
25 disturbing its growing rhythm and even improving the final product.

The above and other aim and objects are achieved by a method for the dietary optimization of growing swine characterized
30 in that it consists of artificially altering the natural gastric motility of the swine, by means of sequential electrical pulses and for selected periods of time, to

prevent or to slow down the emptying of the swine intestines and therefore to lengthen the gastric time of food and the gastric digestion time for a more effective intestinal absorption reducing the fodder necessity of the swine
5 without reducing the weight increase of the swine.

Said process is performed with an electronic apparatus for the dietary optimization of growing swine, characterized in that it comprises an electrical stimulator arranged under
10 the skin at the sternal ensiform apophysis and having means for an electrical connection to the distal antrum of the swine stomach for preventing or reducing the natural gastric motility of said stomach for a selected time.

15 Further characteristics and advantages of the invention will be more apparent by the description of a preferred but not exclusive embodiment of a method and an apparatus for the dietary optimization of growing swine according to the following description.

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For a better understanding of the method and an apparatus for the dietary optimization of growing swine, according to the invention, the motor physiology of the gastric viscus is briefly described.

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As is known, the stomach of an omnivorous mammal, such as the swine, is divided into two parts as regards its motility: the fundus ventriculi, which has tonic wall movements, and the central part, or corpus, which is
30 characterized by phasic activity.

Propulsive gastric movements begin in a point proximate to

the greater curvature (opposite the lesser curvature) which is not clearly identified anatomically and is termed "gastric pacemaker".

- 5 The "gastric pacemaker" sends natural electrical pulses with a frequency of 2-5 cycles/minute; these pulses spread in an anterograde direction along the entire swine stomach in the form of waves which have a sinusoidal shape.
- 10 The antrum of the stomach has a continuous phasic activity which has the purpose of mixing the food which is present in the stomach.

The passage of food into the duodenum is therefore the
15 result of a motility which is coordinated among the antrum, the pylorus and the duodenum 9.

To put it more simply, when the food has passed through the esophagus it reaches the stomach.

- 20 The "gastric pacemaker" spontaneously and naturally generates sinusoidal waves along the entire stomach; these waves allow the antrum, with movements which are coordinated together with the pylorus and the duodenum, to make the food
25 pass into the subsequent portions of the alimentary canal.

Now that the known physiology of the gastric motility of an omnivorous mammal, such as the swine, has been established, the process according to the invention consists in
30 artificially altering, by means of sequential electrical pulses and for selected periods of time, the natural gastric motility of a swine to prevent the stomach to empty or to

slow down the food transit.

More particularly, the electrical pulses are generated by an electrical stimulator comprising means for an electrical connection to a portion of the seromuscular layer of the stomach.

The electrical stimulator is arranged subcutaneously in the abdominal wall - therefore does not appear outside - in a middle position of the ensiform apophysis of the sternum of the animal.

The distal portion of the gastric antrum is the object of the electric pulse produced by the stimulator which, as it will be seen, is biocompatible, as any other material, used in this method, that must reside for a long time inside the animal.

In this manner, the electrical stimulus generates, along the entire stomach, one or more sinusoidal waves which start in the gastric antrum and add, more or less synchronously, to those generated by the "gastric pacemaker" which are instead generated naturally by the "pacemaker" when "emptying procedures" are activated in the stomach.

In other words, the electrical stimulator induces a motor incoordination (the so-called antral tachygastria) in the stomach, working as a high frequency "iatrogenic ectopic pacemaker", in order to slow down or even prevent gastric transit through the pylorus into the intestine located downstream and thus allow a gastric extension of the food with a consequent improvement of the absorption of the food

in the intestine and with a final improvement of the yield of the fodder in terms of weight increase of the animal.

Furthermore, in order to obtain a iatrogenic tachygastria,
5 the electrical stimulator has selected working frequency and periodicity.

Namely, the electrical stimulator has a working frequency comprised between 2 and 20 pulses per minute.

10

Since the natural "pacemaker" of the swine has a spontaneous depolarization every 2 to 5 minutes, the electrical stimulator will substantially have a frequency higher than the pacemaker and therefore of at least 6 or more cycles per
15 minute.

Each of those pulses has a duration comprised between 10 and 90 milliseconds, depending on a specific chronaxie which defines the excitability level of the tissue in terms of
20 length of stimulus with an electrical discharge for each pulse which may vary between 2 and 15 milliampere, with constant current, and between 1 and 10 volts, with controlled voltage, depending on the electrical characteristics of the electrocatheter or of the electrical
25 connection means used, and on a specific rheobase of the tissue to be stimulated.

It has been seen that, in order to determine the tachygastria for periods limited to 24 hours, and in order
30 to limit or prevent the emptying of the stomach, the intestines of the swine are electrically stimulated as above described.

In that case, the swine will be allowed its normal gastric-motility only when the electrical stimulation is interrupted.

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It has been seen that the apparatus for the dietary optimization of growing swine comprises an electrical stimulator appropriately and permanently arranged subcutaneously in the abdominal wall of the animal and is
10 connected to the distal gastric antrum by an bipolar electrocatheter or by any other bipolar electrical connection means for the electrical stimulation of said region.

15 To that purpose, except for the bipolar windows on the tip of the electrocatheter or of any other bipolar electrical connection means with the antrum, the endoperitoneal electrocatheter and the extraperitoneal electrostimulator are covered by inert and biocompatible insulating material
20 having a rough surface (for example with a material known with the Trademark "Velcro") in the portions which cannot be dislocated with respect to the initial allocated position, in order to weld the tissues, thanks to the inflammatory and fibrous reaction that the rough surface provokes in the
25 animal organism.

The operating parameters can be adjusted with an external programmer, such as its activation and/or deactivation.

The invention achieves the intended aims and has important
30 and considerable advantages.

It has in fact been devised a method and an apparatus for

the dietary optimization of growing swine, in order to improve the yield of fodder in terms of weight increment, at the same time reducing the undigested fecal residue and reducing the cost of disposing of the organic fluids, without disturbing the growing rhythms of the swine and improving the final product.

The method and apparatus according to the invention may have numerous modifications and variations, all within the inventive concept.

Furthermore, all the details may be substituted with technically equivalent elements.

The materials employed, as well as the dimensions, may be any according to the specific needs and the state of the art.

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CLAIMS

1. Method for the dietary optimization of growing swine characterized in that it consists of artificially altering the natural gastric motility of the swine, by means of sequential electrical pulses and for selected periods of time, to prevent or to slow down the emptying of the intestines and therefore to lengthen the gastric time of food and the gastric digestion time, for a more effective intestinal absorption reducing the fodder necessity of the swine without reducing the weight increase of the swine.
2. Method, according to claim 1, characterized in that said sequential electrical pulses are generated by an electrical stimulator comprising means for its electrical connection to the seromuscular layer of the gastric antrum.
3. Method, according to claim 1 or 2, characterized in that said electrical stimulator is arranged subcutaneously in the abdominal wall in a middle position at the ensiform apophysis of the sternum of the animal.
4. Method, according to claim 2, characterized in that said electrical stimulator has a selected working frequency dependent from the variation of the desired stomach motility.
5. Method, according to claim 2, characterized in that said electrical stimulator generates a one or more sinusoidal waves along the entire said stomach, each of said waves being equal and contrary to the waves naturally generated by the gastric pacemaker of said stomach, said sinusoidal waves having an anterograde direction for producing an antral

tachigastria in said swine with a consequent interruption of the propulsive motion activity of said stomach for a selected time.

5 6. Method, according to claim 2, characterized in that said electrical stimulator has a working frequency comprised between 2 and 20 pulses per minute.

7. Method, according to claim 6, characterized in that each
10 of said pulses has a duration comprised between 10 and 90 milliseconds depending on a specific chronaxie defining the excitability threshold of the tissue in terms of length of stimulus.

8. Method, according to claim 6, characterized in that each
15 of said pulses has an electrical discharge comprised between 2 and 15 milliamperes with constant current and between 1 and 10 volts with controlled voltage, according to the electrical characteristics of the electrocatheter or of the connection means and to a specific rheobase of the
20 tissue to be stimulated.

9. Electronic apparatus for the dietary optimization of growing swine, characterized in that it comprises an electrical stimulator arranged under the skin in a middle
25 position at the sternal ensiform apophysis of said swine, said stimulator having means for an electrical connection to the seromuscular layer of the gastric antrum wall.

10. Apparatus, according to claim 9, characterized in that
30 said stimulator has a working frequency comprised between 2 and 20 pulses per minute, each of said pulses having a duration comprised between 10 and 90 milliseconds and an

electrical discharge comprised between 2 and 15 milliamperes with constant current and between 1 and 10 volts with controlled voltage, according to the electrical characteristics of the electrocatheter or of the connection means and to a specific rheobase of the tissue to be stimulated.

11. Apparatus, according to claim 9, characterized in that said electrocatheter is a bipolar catheter which, together with said stimulator, is covered by a biocompatible inert insulating material having a rough surface in the portions which cannot be dislocated with respect to the initial allocated position, in order to weld the tissues thanks to the inflammatory and fibrous reaction that the rough surface provokes in the organism of said swine.

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 94/01658

A. CLASSIFICATION OF SUBJECT MATTER

A 61 N 1/36

According to International Patent Classification (IPC) or to both national classification and IPC ⁵

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A 61 N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0 129 483 (MEDTRONIC) 27 December 1984 (27.12.84), the whole document. ---	1,9
P,A	EP, A2, 0 571 938 (CIGAINA) 01 December 1993 (01.12.93), the whole document. -----	1,9

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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ANNEX

to the International Search Report to the International Patent Application No.

ANNEXE

au rapport de recherche international relatif à la demande de brevet international n°

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In Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
EP A1 129483	27-12-84	AU A1 28837/84 CA A1 1239998 JP A2 60058171	20-12-84 02-08-88 04-04-85
EP A2 571938	01-12-93	EP A3 571938	26-01-94