An Agenda for Growth and Metabolism Research in Farm Animals: Healthy Food for a Healthy Nation

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Abstract

The aim of this paper is to present a paradigm shift from meat demand to health driven understanding of the effects of livestock production and meat consumption in human. Included are comments on animal nutrition research with the purpose of getting more relevant health information. The growth and metabolism research covers the principles from feed intake regulation, nutrient digestion, absorption and growth. Meat preservation provides enough food for the urban population, and its major ingredient includes the combination of salt, sugar and fats, suspected to cause food addiction in man. The reported effect of processed red meat causing systemic inflammation is a major consideration in food preparation, diet selection and reasonable control for meat consumption. In livestock "Pharming" the danger of heavy metal contamination of commercial feed poses threat to human health aside from drug residues. It is proposed that the 50% of global greenhouse gas is due to the lifestyle of the rich and epidemic of obesity-related diseases are the effect of livestock "Pharming" and addiction to fast food and or processed meat.

1. Introduction

There has always been an increasing demand in meat products justified by increasing population, increasing income and urbanization ([1], [2]). From 1980 onwards, the growth in the per capita consumption of livestock in developing countries outgrow the other major food commodities, such as cereals, root crops/tubers and milk [3]. According to FAO the per capita consumption of meat in developing country in 1980 and 2005 is 14.1 and 30.9 kg, respectively while in developed countries it is 76.3 and 82.1 kg. Although the increase in developing country is 16.8 kg and only 5.8 kg in the developed country for 25 years, the provoking question is, "Does developing country need to consume meat the same amount the developed nation consume?". They should not, because the body size of the people in the developing country is just half or more than half the size of the developed nation.

Obesity is defined as individuals with body mass index above 30. Obesity – related diseases, such as diabetes, cardiovascular, cancer and arthritis are mostly degenerative diseases. According to WHO (2017b) [4], in 2016 the world obesity tripled since 1975. WHO (2017c) [5] reported that the global obesity in 2016 has been mapped, listed from lowest to highest are India (19.7%), Philippines (27.6%), Indonesia (28.2%), Canada (64.1%), Australia (64.5%) and USA (67.9%). India per capita meat consumption is 3.7 and 5.1 in 1980 and 2005. The country's average per capita meat consumption and average incidence of obesity apparently shows direct association.

2. Discussion

This paper goes beyond the capitalist idea of raising livestock to meet the meat demand of the increasing population in the urban and economically able consumer of the developing countries. This paper attempts to present relevant principles on the (1) feed intake regulation; (2) compensatory growth mechanisms; (3) animal nutrition research; (4) heavy metals in commercial feeds and (5) the framework for human health agenda.

Feed Intake Regulation

The Voluntary Feed Intake (VFI) covered in this paper is classified into two, (a) the physical regulation and (b) the metabolic regulation. The physical regulation is composed of the oropharyngeal metering and the stomach distention or the gutfill. The metabolic regulation is composed of the following: (a) Volatile Fatty Acid (VFA) regulation in ruminants; (b) hormonal regulaton and (c) the Hepatic Oxidation Theory. Although voluntary feed intake regulation principles maybe associated to man, there is no 100% assurance that the same follows in human. A more troubling concern in humans is the unravelling of the incidence of eating or food addiction intentionally included because of the research agenda of providing healthy food towards a healthy the nation.

The oropharyngeal metering theory of food regulation is the concept that there is something in the mouth and pharynx that counts or measures the food that passes until it gradually slow down and stop. This idea was derived from surgically implanted balloon beyond the pharynx that collects the feed that enters the mouth. The possible reason for this oropharyngeal feed intake regulation could be the emptying of the saliva from the salivary gland that initially digest the feed and or the muscles for mastication and chewing get tired, such as the digastricus, masseter and pterygoid muscles.

The stomach distention or gutfill is simply attributed to the capacity of the stomach to accommodate feeds [6]; hence surgically reducing the size of the stomach may surely result to reduction in the voluntary feed intake and body weight consequently. In 2005, Kogima et al. published in nature magazine the linked between the stomach/gastrointestinal tract and the brain by the secretion of Ghrelin, a 28 amino acid peptide considered as orexigenic (hunger hormone). Ghrelin secretion is high during hunger or underfed state, transported by the blood, passes the blood brain barrier, and acts on the receptor (GHR) in the hypothalamus to stimulate appetite and also in the anterior pituitary gland to stimulate secretion of growth hormone.

The Volatile Fatty Acid and gutfill regulation in ruminants is considered anorexigenic ([7] [8]). Both VFA and gutfill regulations are connected because the infusion of VFA in the rumen of cannulated ruminants that results to linear depression in voluntary feed intake is in the form of acid. Increasing amount of salt resulted when increasing VFA solution was prepared to attain similar pH with the rumen environment. Therefore, the linear depression in feed intake attributed to increasing VFA concentration is in combination with salts. Hence this feed intake reduction due to VFA cannot just be attributed to metabolic regulation but to physical regulation as well because of the increase in osmotic concentration on the lining of the rumen due to salt combined with VFA. Separating the associated feed intake depression due to specific components of VFA such as acetate, propionate and butyrate reveals differing amount of linear increase in feed intake reduction [7]. Therefore the VFA infused depression in feed intake is a combination of both salt and VFA.

The Hepatic Oxidation Theory (HOT) in ruminants was proposed and presented by [9], which states that feed intake is controlled by oxidation of fuels in the liver. According to the authors feed and energy intake of ruminant animal can change dramatically due to change in diet composition and metabolic state. The hepatic oxidation reduction in feed intake is made possible by the vagal reflex due to increase in fuel oxidation or generation of ATP. This has been found consistent with propionate higher feed intake reduction relative to acetate, butyrate and lactate which has been found negligible to very low [9]. The control of feed intake by hepatic oxidation becomes higher when nutrient demand decreases, hence gutfill increases. Hence in times of increasing milk production in dairy animals VFI

regulation is influenced more by the gutfill and less of the metabolic or hepatic oxidation. Therefore the application of the combined hepatic oxidation and gutfill regulation can be used in the dairy production by increasing the proportion of concentrate over the roughage in the diet as the milk production rises to its peak and vice versa as the milk production declines up to the dry period.

The hormonal regulation of feed intake has been understood to be controlled by orexigenic Ghrelin and anorexigenic insulin, cholecystokinin (CCK) and leptin. Orexigenic stimulates appetite and anorexigenic hormones reduce the voluntary feed intake in farm animals as well as in man. Leptin influence of feed intake reduction in cattle is only 25% at a condition when plasma leptin is elevated through lipogenic action at fattening stage in cattle (Vega et al, 2013). The eating and food addiction in man may have two possibilities that need further research, i.e. the stimulation of the Cocaine Amphetamine Receptor Transcript (CART), Proopiomelanocortin (POMC) and the Dopamine D2 Receptor (D2R). The D2R is the likely link in the addiction – like reward dysfunction reported in rats by [10].

Compensatory Growth Mechanisms

Growth Rate & Feed Conversion Ration with age decrease and follow a curvilinear pattern in swine ([11]; [12]) in dairy beef [13]. The principle that ADG and Feed Conversion Efficiency decrease with age can be explained by the fact that maintenance energy increase with increase in metabolic body weight. Therefore it seems economical if livestock are produced and slaughtered at earlier age. Researches are needed to have this validated across farm species.

Compensatory Growth, Realimentation, and Catch-Up Growth are interchangeable used and it is defined by [14] as physiological process whereby an organism accelerate its growth after the period of restricted development caused by energy and protein restriction. In Holstein Steers, feed restriction from 38% of the mature weight by withdrawing concentrate feed allowed the animals to undergo compensatory growth [15] [16] This was similar to the findings that animals exposed to feed restriction 25 to 30% of the mature weight can rebound and gain weight similar to the control or ad libitum fed. Compensatory growth research should further be explored as a research topic because its application may be naturally occurring, e.g. during summer and winter for grazing cattle. In compensatory growth principle implies that growing animals beyond 35% of mature weight should be allowed to undergo nutritional stress.

Animal Nutrition Research

Animal nutrition research is conducted with the aim of increasing the body weight of farm animals. The principle involve in digestibility study is nutrients consumed minus nutrients excreted is equals to digestible nutrients. In the conduct of feeding trial, most parameters taken are feed consumption, body weight gain and average daily gain. Other parameters are computed as feed efficiency or feed conversion efficiency. This is driven by the fact that the product sold is live weight in kg., the measure of economics is basically the cost of feed offered and income from live weight sold. If the ration/diet is economically feasible they are applied in the large scale commercial production. Food safety issues in animal nutrition research are not considered, only when the animals died. How about the issue of systemic inflammation? Systemic inflammation is the increase in body weight because toxins and residues in feed causes inflammation of the villi or linings of the small and large intestines that allows the unwanted substances to pass through, this is the case of leaky gut syndrome. Residues that enter the animal's body can cause inflammation where they are deposited. After the successful rat or mouse experiment, pigs for biomedical research are now becoming necessary before human clinical trials is conducted for a successful drug application. Therefore a "One Health" program is becoming necessary which can be done not just by the medical, veterinary, researcher/ scientist of the drug companies but also by the animal scientist. Understanding the total effect of the diet in swine research extending it to assay pesticide and heavy metals in feed, gut

microflora, small intestines villi, visceral condition and other blood parameters for possible endocrine disruption may provide useful information to extend the benefit of research not only for capitalist interest but for human health.

Heavy Metals in Commercial Feed and Edible Tissues

In ducks heavy metal Cd beyond 0.025 ppm [17] is 80% of all commercial feeds shown in Table 1 (Octura et al, 2017). Based on this exploratory survey and sampling of feed and ducks it was found out that visceral organs, i.e. the liver and ovary poses Cd threat. Liver and ovary have very high amount of Cd ranging from 0.40 to 1.17ppm, i.e. beyond weekly tolerable intake of 0.025ppm by EFSA (2009).

In pigs, Table 2 shows Cd content in ration and very high in pre starter (1.33), starter (1.12), grower (1.18), breeder (1.35) and finisher (1.43 ppm). The 0.46ppm Cd are released in manure. Hence it is not advisable for use as organic fertilizer. The liver, blood and meat have 0.849, 0.104 and 0.069 ppm Cd, respectively. Analyzing the each feed ingredients used, on the highest concentration of Cd in ppm is biofos (12.03), salt (7.1), mineral premix (5.32), antioxidant (4.48), zeolite (3.74), mono Calcium Phosphate (2.71), vitamin premix (1.62), US Soya (0.68), Rice Bran (0.64), Cassava (0.39) and Ground Corn (0.19). Aside from drug residues in meat of livestock “Pharming”, heavy metal Cd is another threat to health of consumers. Cadmium is not biodegradable and it accumulates in the environment, in the air, soil and water through time. Therefore control in the consumption of processed meat and meat per se must be dealt with if quality and healthy life is our goal in.

Framework for Human Health Agenda

It is the moral responsibility of teachers to be healthy, because students do not just listen to what they hear but in what they see. The message is to disseminate a healthy lifestyle so that we will live life in happiness and in health. The proposed framework for human health agenda is directed towards reducing the emission of greenhouse gases and control of food addiction specially processed meat for health reasons. To make this proposed framework a reality, the foundation must be grounded on established facts and carefully derived principles.

The prevalence of addiction to fast food products and processed meat is growing worldwide coupled with the prevalence of obesity and its related diseases. According toRabobank International (unpublished), the projected livestock demand is 40% in 2030 and 70% in 2050. Looking at their graph clearly it is not the lamb (4%) and beef (20%) that increase in demand, but the pork (37%) and poultry (39%). Therefore, it is the urbanization, fast food chain, processed meat in the supermarket that drives the demand for meat.

Table 1. Mean Cd content in mg/kg (ppm) of commercial feed samples in selected farms of Laguna and Pampanga. (EMDL = 0.04 mg/kg)

Commercial Feeds	LOCATION				MEAN
	Laguna		Pampanga		
	mg/kg	% Users	mg/kg	% Users	
A	<EMDL	9.0	0.16	26.7	0.08
B	0.44	27.3	0.29	6.7	0.37
C	0.46	9.1	0.16	20	0.31
D	-	0	0.12	6.7	0.12
E	-	0	0.84	26.7	0.84
F	-	0	0.83	13.3	0.83
G	0.14	9.1	-	0	0.14
H	<EMDL	27.3	-	0	<EMDL
I	0.12	9.1	-	0	0.12
J	<EMDL	9.1	-	0	<EMDL
Average Cd mg/kg	0.186		0.437		0.311

The Guardian (2017) [18] an independent investigative journal publisher report that 10% of the richest people produce half of the global CO_2 emission based on lifestyle consumption emission. The lifestyle of the rich would mean just a taste-then-waste, extravagance and overly designed appliances/ cars.

Based on the rule of thumb on dietary requirements, our plate should have 25% rice, 25% fish or meat, 25% vegetable and 25% fruits. This balanced diet is not served in almost all fast food. Most children addicted to fast food and processed meat turned obese early in life and failed to live life in happiness and health. The many unwanted residues in commercial feeds and the added preservative in meat to keep its keeping quality for a long period of time are the possible reasons why meat consumption is linked to unhealthy life.

Looking at Figure 1, the framework clearly states that the rich are the contributor in global greenhouse gas emission and in both rich and poor the higher per capita meat consumption the greater the possibility that an individual is developing an unhealthy lifestyle. The framework tells us that the extravagant lifestyle of the rich contributes a lot in global greenhouse gas. Moreover, regardless of our economic status, addiction to fast food and or processed meat brings us to unhappy and unhealthy life. Therefore our action must be based on reason and not on emotion, for the rich to live simple life, share their wealth and for all to control addiction to fast food and or processed meat.

Table 2. Concentration of Cd ± SD[1] (ppm or mg/kg) of formulated rations[2], manure and edible parts/ tissues taken from farmers field (February to September 2014)

CLASSIFICATION	SAMPLE	N	MEAN ± SEM[3]
FORMULATED RATION	Pre-Starter	2	1.33 ±0.27
	Starter	2	1.12 ±0.03
	Grower	2	1.18 ±0.06
	Breeder	4	1.35 ±0.12
	Finisher	1	1.4275 ±0.0
ORGANIC FERTILIZER	Manure	8	0.46 ±0.125
EDIBLE PARTS	Liver	6	0.849 ±0.22
	Blood	4	0.104 ±0.07
	Meat	6	0.069 ±0.03
FEED INGREDIENTS	Rice Bran	2	0.635 ±0.13
	US Soya	2	0.68 ±0.0
	Ground Corn	2	0.19 ±0.21
	Cassava Meal	1	0.39 ±0.0
	Mono Ca-P	1	2.71 ±0.0
	Biofos	1	12.03 ±0.0
	Zeolite	1	3.74 ±0.0
	Antioxidant	2	4.475 ±2.55
	Mineral Premix	2	5.315 ±1.72
	Vitamin Premix	1	1.62 ±0.0
	Salt	2	7.1 ±0.07
	DL – Methionine	1	ND
	Choline Chloride	1	0.04 0.0
	L- Threonine	1	ND
	L - Lysine	1	ND
	Limestone	2	8.22 ±0.07

[1] Heavy metal Cd was analysed using AAS-Flame method at the Analytical Service Laboratory of the National Institute of Molecular Biology and Biotechnology, UP Los Baños;

[2] The feed companies available in Sta. Cruz watershed were LIMCOMA, UNAHCO, Primera, San Miguel, Masagana and Robina;

[3] ND= Non-detectable; Provisional Tolerable Monthly Intake (TDI) is less than 0.025ppm (25ug/kg b.w.) as imposed by EFSA 2009

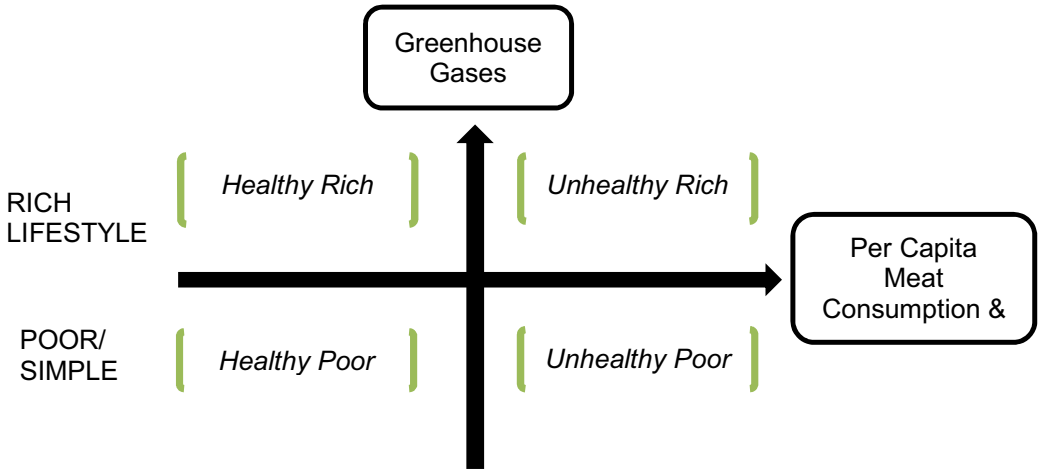

Figure 1. Framework for Understanding the Effects of Livestock "Pharming" and Lifestyle of the Rich to Greenhouse Gas Emission and The Food Addiction to Fast Food and or Processed Meat to Human Health

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