Alternative meat chicken production ; is our nutritionnal knowledge sufficient for their further development in EU ?

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Abstract

During the last 40 years development of meat poultry in the EU, alternative mode of production have arisen, mainly in France,. It is mainly whole chicken specially from slower growing birds or medium growth birds raised in certified conditions, including organic ones.
Nutrients recommandations are similar to fast growing birds and responses to major nutrients variations like also,specially in the early stage but energy requirements differs for maintenance mainly because alternative birds are more active.
Higher pollution brought by alternative birds is to be adressed ; separate energy and protein feeding, nutritional specifications and physical form of feeds adaptations are interesting potential solution that can also help to increase control of coccidiosis.
Economical and ecological optimization of feeding is a key for alternative productions to adapt to consumers changing demands.Medium growing chicks may be the more adaptable and able to compete with potential import competition.

Introduction

For a senior feed company nutritionist, it is ironical to name now alternative poultry production what has much in common with the standard production in the mid 50s in western Europe; free range, small scale operations, low density flocks, simple housing, grain based feeding, no chemical drugs, slow growing animals etc…
At that time alternative poultry meant industrial organizations raising at first chicken or layers, then turkey, duck or guinea fowl in closed houses with fast growth selected breeds and cost optimized compound feeds increasingly including food industry offals/byproducts , chemical minerals and additives.

This requires to define « alternative poultry» nowadays not as a « new »minor species production (quails, guinea fowl, game birds, ratites…) replacing a previous major one, but as a diversification into any non- or less - industrial meat production systems from existing breeds
The continously increasing registered poultry production in european countries has been massive, from 7.6 million tons in 1994 to 9 million in 2004 in the UE 15 and from 1 to 2 millions in the incoming 10 countries. Besides, traditionnal backyard production of chicken , turkey, guinea fowl, ducks and geese, although escaping most statistics accounts, are thought to be in a steady decrease everywhere.
Statistics for alternative meat chicken production in the UE 15 are not as reliable as those of layers following reglementary constraints (R. 2295/2003, art. 29 ;1) as alternative layers reach 24.5% of total 2003 EU-15 controlled flock.
This proportion is certainly much smaller with poultry meat production with notable exception of french market were slow (2.2 kg at 82 days) growning « label »chicken breeds (SG) and their cross breeding with fast (55g/d) growth birds (FG) give medium (40 g/d) growth birds (MG) with certified production scheme and strong commercial brands. Some guinea fowls, turkeys and ducks are also produced as alternatives to industrial production ;
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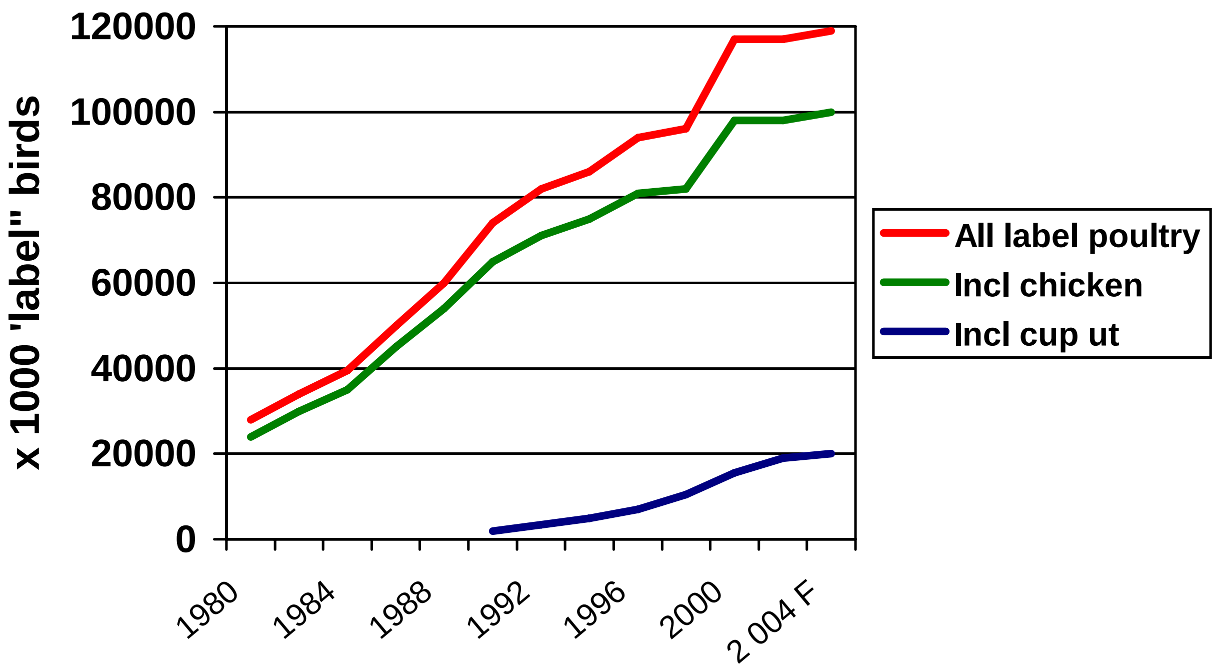
As shown in **fig 1** for all major meat poultry species and **table 1** an important part of the progression in France is linked with the developpement of alternative productionbut essentally in SG chicken meat .

Table 1 : Repartition of different alternative poultry in France (from ITAVI 2004)

Annual total production (1000 tons)	Poultry species concerned	Standard Industrial % each species total tons	Alternative poultry split into main categories % total of each species			
			MG certified	SG label	Organic	Others AOC etc…
1 000	Chicken	74	8	16	1	1
615	Turkey	91	8	-	-	1
190	Duck	60	34	4	-	2
215	Guinea fowl	57	3	37	2	2

Fig 1 : number of french label birds increase from 1980, part of whole and cut chicken



We shall concentrate in the following presentation **only on chicken**, as there is even less answers for minor species to similar questions raised for chicken.

Diversity of alternative chicken production

Diversity seen on the chicken meat market comes from an attribute or a combination of attributes related to customers wishes:

- a geographical area origin for safety and reliability guarantees
- a special chicken breed or group of breeds or crosses different from standard ones for instance for higher meat quality ,or specific look ,feathering (nude-neck) , rusticity, color of feathers or legs…
- a certified production specificity adressing feed ingredients, breed spécificity, slaughter age, density… and generally identified by a brand name also to adress safety and reliability
- a recognition of the environnementaly friendly poultry production with farming constraints the more limitating one being the organic farming.

So we can see in the EU alternative chicken product featuring area origin only (ex Catalunya origin) or a combining area specificity with a designed local breed and mode of farming (ex french blue legs Bresse poultry finished with maize and skim milk) .

A majority of alternative birds in the market are typically a 2,2 kg MG bird slaughtered at 56 days or 82 days for SG « label »one's.

A very small part of the market (1%) exist for chicken from standard breeds raised in specified environnement, for image, environnemental and welfare reasons, like organic chicks.

Rules of production are generally privately certified and/or regulated, for instance EC 1804 /1999 for livestock biological « organic »production after EEC 2092/91 general reglementation on biological « organic »agriculture.

Chicken organic production has suffered from very restrictive regulations and in France and of the strong development of the « label » production ,that organized as early as 1965., but the it is now at a plateau as MG certified production is growing, especially for futher processing .
Are this wealth of different chicken productions have different nutritionnal requirements ?

Aternative chicken nutritionnal recommandations, science and practice

Nearly all the research on nutrition in poultry has been focused on highly selected FG animals and controlled environnement not on SG or MG raised in uncontrolled one and lot of nutritionnnal research is more than 20years old

For example on **micro elements** requirements are dating from 20 sometimes 50 years. They and could be more relevant for SG and MG birds than modern FG ones as there is probably some genetic differences in specific requirements., never taken in account in practice

With a feed conversion about 50% higher than standard FG chicks and similar recommandations per kg feed (see table 2) a priority could be in lower inclusion research in feed for Zn ,Mn, Cu Se … that are under EU legislators scrutiny.

As these microelements are more linked with maintenance, stress etc.. than growth, LG birds could have lower requireemnts as FG that are more susceptible to stress and have lower liveabilty.

This liveability and difficulty of adaptations of FG explains that on SG and MG chicken commercial farms, only specific breeds can be used as well as in organic production.

Table 2 : main nutritional recommandations for mixed sex chicken, depending on their growth rate, fast (FG), medium (MG), slow (SG).

Type of meat Chicken	*** FG (55 g/d) standard indust.**		**** MG (40 g /d) certified cross-bred**			**** SG (28 g/d) « label » breeds**		
Growth period	0 – 21d	22 – 42d	0 – 21d	22 – 42d	43 –56d	2 – 28d	29 – 63d	64 – 84d
Intake (g)	880	2590	800	2000	2400	750	3000	2950
MEn (kcal/kg)	3200	3200	2900	3000	3050	2850	2900	2950
Crude prot %	23	20	22	19	17.5	21	19.5	17
Lysine %	1.10	1.00	1.20	1.10	1.00	1.17	1.02	0.78
Met. + Cyst. %	0.90	0.72	0.95	0.85	0.80	0.88	0.80	0.68
Threonine %	0.80	0.74	0.82	0.76	0.77	0.77	0.68	0.51
Arginine %	1.25	1.10	1.30	1.25	1.15	1.29	1.13	0.86
Tryptophan %	0.20	0.18	0.24	0.22	0.20	-	-	-
Ca %	1.00	0.90	1.05	1.00	0.90	1.10	0.95	0.90
Pav %	0.45	0.35	0.48	0.42	0.38	0.48	0.42	0.38
Na %	0.20	0.15	0.17	0.17	0.17	0.17	0.17	0.17
Cl %	0.20	0.15	0.18	0.18	0.18	0.18	0.18	0.18
Zn mg/kg	40		70			70		
Cu «	8		10			10		
Fe «	80		50			50		
Mn «	60		60			60		
I «	0.35		1			1		
Se «	0.15		0.20			0.20		
Vit A UI/kg	1500		1250			1250	1000	1000
Vit D3 «	200		250			250	200	200
Vit E mg/kg	10		30			30	30	30 - 100
Vit K «	0.50		2.50			2.50	2	2

*** from NRC Tables 1994** **** from Hubbard ISA technical doc n°4 2002**

Macro minerals requirement, more linked with growth rate that maintenance could also be questionned especially for **P** emission ; Present recommandations are not in favor of SG and MG birds fed high phytic acid P content feeds ,especially as FG one have seen their available P requirement decreased recently as well as general use of phytase to improve P retention

Evialis poultry specialists contributed in 1997 and 1998 to determin practical use of phytase in 4 comparative field trials. SG birds were JA 657, mixed sex,kept in 2 farms, each with twin 400 m2 buidings (a control and a trial) to test Natuphos 5000 G (BASF) phytase. The dry additive was uniformly incorporated in starter grower and finisher at 600 UP /kg and feeds were formulated to obtain an average 75% or 80% grain content and satisfy ISA tables recommandations as in table 2 , birds were slaughtered at 82 days.

First test didn't take in account available P derived from phytse activity, in the others it was equalized on the assumption of 0,08 % av P and 0,12% Ca brought by phytase inclusion so that total P reduction in feed was in the range of 11 to 14%.

Performance for growth and .feed conversion where always improved by phytase mainly during starter (30 d) period and mineral reduction during finishing period was positive for intake especially during summer indicating that av P % in feed could be further reduced even when feed intake is low.

Concerning **Na, K, Cl, Mg** their requirement are linked more with maintenance than with body growth and their requirement, assuming good acid base balance is maintained and compounders have the same practice as for FG animals.

. Comparison of recommandations for growing standard, medium and slow growth (label) given in table 2.show that alternative birds recommandations for most nutrients are similar to FG on same energy basis, with some higher values for safety margin but in the range of 10% .

As most **major nutrients** requirements are adjusted relative to **MEn** content of feed, the first question is to check that feed **MEn is similar in SG and FG chicks ;** that was demonstrated by Barier-Guillot et al 1997 that found an average difference of only 2% in apparent MEn in favor of SG birds compared with FG one, with some variations depending on age of birds, fat level and energy concentration of feeds tested.

.Indeed, with a reduced appetite SG birds may have a higher digestibility of feed especially those with slow degrading nutrients because we can expect a slower food passage .In contrary an increase in endogenous losses could be expected as relative size of SG birds gut to their body weight is higher. A higher protein digestibilty was found by HALLE and DANICKE , 2001 using a SG strain from ISA compared to Ross FG broilers .We can also speculate that enzyme and/or bile salt secretions might be less limiting for SG, especially for fat digestion in the early age than for FG birds.

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Situation is more confused when it comes to MEn use for production .A special energy metabolic situation like heat stress for instance is clearly much less tolerated by FG chicken compared with SG ones (Yalcn et al 2001) and it is an important feature of certain adapted breeds like Kabir or black nake necked birds like Acoblack from ISA.

Indeed FG birds selection has lead to hyperphagic animals with very limited satiation mecanisms and very high protein accretion, then temperature increases will not change very much proteolysis and the heat produced in the tissues but strongly reduce rate of protein synthesis and impair growTh and metabilism regulation..

In the contrary SG birds are selected for lower energy maintenance by combining low feed conversion (or slow fat deposition) and slow growth and body protein deposition.

As a consequence,following Quentin et al (2004) in it's **energy requirement for chicken growth model discussion** , energy for FG bird fed to zero production could be an average 2 fold that of a SG one on metabolic weight basis , the author citing values varying from 58.2 to 267 kcal/d/kg P3/4 .He also mentions the large difference of physical activity and subsequent energy requirements between « dynamic » SG and increasingly « static » FG with age. In climate controlled situation Wiers et al.(2001) have similar conclusions As measured by MacLeod et al. 1982 , FG bird lying 65% of the time spend 7% of ingested ME for maintenance ,so SG and MG that have much higher activity and lower intake spend much more, close to 15%. It is estimated to cost 50J /Kg metabolic weight (0.75) more ME for standing than when lying and a higher heat production. is associated to standing.

As body composition is not that different at similar weight from SG to FG birds and do not account for big differences in energy carcass deposition we require to have a precise activity budget of the chicken at farm level to adjust energy requirement precisely.

Feed fat content doesn't seem to influence efficiency as field trials results (Hubbard Isa technical info N°3 (2002)) comparing ME conversion at 56days of MG strain 957 fed with balanced high or low energy concentration feeds give the same value (6,23 Mcal /kg at 2.56 kg live weight)

As optimum **amino acid** balance for growth is largely different from that for maintenance , especially for lysine and sulfur amino-acids (INRA 1984) , we can expect some consequences on amino acid balance depending on birds growth rate, also fast feathering strains may require higher EAA as cystine and threonine and indeed the latter that was found by DOZIER et al 2000 to be more limiting for growth rate after 6 weeks of age for fast feathereing SG breeds.

Imposed high grain inclusion (80%) in feeds is limiting crude protein content often as low as 14% in finishing feeds . All sorts of other ingredients constraints are found in alternative feeding rules that makes formulation on amino acids for SG birds not very flexible,so possible impaired feed conversion if not growth rate could come from amino acid imbalances specially during summer when intake is low.

This lead feed formulators to have pelleted and crumbled feeds in summer to stimulate intake for the SG birds and feed factories to carefully monitor ingredients grinding to maintains fines low and coarse particles high enough in meal .

Switching from meal to crumbles or pellets, as an average, improves intake by 12% , but changes from a physical form to another may be critical in behaviour in a SG flock (pecking , changes in feeding time etc…).The problem is not frequent with MG birds that are mostly fed pellets as they have to be stimulated by all means to eat to reach their maximum growth rate.

As the protein level may be in practice sublimitant we can question a possible **non esssential amino acid** effect on SG birds performances.

At our Evialis Talhouet experimental farm (non published data) we have tested the ability of SG slow feathering black nude neck (Isa Acoblack) males and females to react either at a 10 % concentration of amino acids alone or 10% amino acids and protein together or to higher feed intake stimulation obtained ad libitum by changing the physical form of the feeds. Comparing 5 feeding programs 2 with different protein content (18 vs 17%) with or without balancing the amino acids on energy (MEn) and 3 programs compairing physical forms, crumbles vs medium or coarse meal as starter and grower then pellets to replace crumbles at the finishhig period.vs medium (d50=1050 microns) and coarse meal.(d50=1500 microns)

Most of the differencies were seen during the 4 weeks starting period with an increase of total period feed conversion (+4%) and a reduction in growth (-4.8%) for meal compared to pelleted forms, spillage of feed in meal form may be a part of the explanations as the coarser feed the better.

As expected amino acid concentration had a slight n.s.benefit effect mainly on feed intake for the 12 weeks total period but this effect is much higher (+6.8%) during the starting phase. Rebalancing higher level of amino acid with an increase in energy had no overall effets but a slight improvement (4,2%) of feed conversion during the 4 first weks of growth.

As essential amino acids have limited effect on performance at least after the starting period, we wished to understand the possible effect of non essential one on maintenance, feather and gut of SG birds that could be different of those well studied for the FG birds requirements predictions.

Using the standard « label chick » housing and production references in controlled free range conditions at the ENSAT laboratory farm , with A.Auvergne and R.Babile (unpublished data) we compared 4 feeds given after after a 4 weeks commun starter to 150 Sasso 451 groups. Compared to a control 17% protein satifiying the SG breed recommandations (cf table 2) we had group 1 with limited non essential amino acids by reduction of protein to 15% but maintained essential amino acid level of the control, a group 2 with both essential and non essential amino acids reductions at 15% protein level then a third comparison with again 15 % protein and same amino acids as group 2 but decrease in energy to provide the same prot/Men as the control (56 g/Mcal) in contrast with the 2 other groups wher this ratio is only 49,5 . Samples of 4 representative chicks where analysed for feather and carcass composition after dissection at 4,8 and 12 weeks of age in each group to understand possible changes linked with feed nutritionnal design.

As expected we had a effect of essential amino acids reduction persisting at 12 weeks on weight and feed conversion independant of the prot/me ratio , feed conversion was 3.11 and 3 .17 for the first 2 groups and 3.19 and 3.34 for the others.

Feather deposition (average 36.7 g/kg life weight) is mainly linked with life weight, little sex dependant and influenced by the essential amino acid intake, as the global N deposition in the carcass as the protein concentration is unchanged across the groups. Fat content increased with age and deposition is highest for the control group (341 g) as the lower protein ones are leaner (250 g fat deposition).

So in the ad lib conditions and with SASSO 451 line, the reduction of protein in feed has limited effects on protein deposition but fat seems to come for a part from the non essential amino acids .

From these observations with different SG breeds we can **conclude** that present recommandations are convienient for performances and carcass quality but the energy requirements for activity and for maintenance are difficult to asses, much variable, and susceptible to differ for breeds and mode of breeding.

Challenges for succesfull alternative poultry production

Good image of alternative production is the more important marketing differenciation of alternative poultry products, but at least **3 threats** ,linked with feeding and nutrition, are limiting their development.compared with conventional birds ;expensive feed formulation constraints, less efficient nutrients utilisation that leads to higher environnemental concerns , and difficulty to maintain high hygiene standard in open systems even if feed can be involved to control gut borne pathogens.

Besides these threats what are the **challenges** ?

-**genetic** is a trump for alternative.production. A lot of differenciation of traits are available and cross breeding is a very flexible tool to adapt to changing demand provided growth prediction models can help to select the adequate breed . Models optimizing the margin per day per bird that takes in account feed price ingredients, behaviour requirement and breed nutrional response in terms of value of parts of the carcass on different markets could bring some flexibilty and capture more potential added value, see INAVI ,Quentin 2004

-**alternative feeding systems** are also aiming at feed costs reduction,reduction of rejections in the environnement , influence gut heath and keep a good marketing image of the alternative farming. Interesting research is under development to understand the rationale of **sequential feeding** of broilers with a high energy and a high protein feed to produce heavy boilers (Bouvarel et al 2004) that could be beneficial with alternative birds ,as they have similar choice of prot/energy feeds according to Picard et al (1997) Concentration of protein in the feed is an important determinant of energy rich volontary consomption and a maximum of 8 hours has to be respected after high protein feeding and energy supply to maintain proper growth.

A variant of these techniques , use of **whole grains** (wheat or maize), is used for decades in alternative poultry not only for image but also because it reduces litter moisture and ,in certain conditions, reduce anticoccidial infestation and spreading .It has no adverse effect on growth, feed conversion and carcass composition at least if they are at low (15%) inclusion rate .

Alternative **health control** in free range chicken ,through feeding as an alternative to widely used vaccination for alternative SG birds and is efficient but less than with drugs in field surveys (Clave and van der Horst, 2004), is justified by the risk of resistance and the possibility to use herbs and natural products in the feed

With A. Auvergne (unpublished data) we tested on Sassso 451 N at ENSAT experimental farm the effect of 2 plants extracts after inoculation at 14 days with 100 000 ocystes of E. acervulina 10 000 of E. tenella and 1000 of E maxima . We didn't found much overall intake and growth impairement, that was only seen the week following inoculaton. As a result a good (3.1) feed conversion was measured either with monensin 100 ppm and any of the researched essential oils.

Untreated birds had an initial reduction in weight gain of 12% compared with monensin treated ones but recovered and ended up at 3% less only, showing a good adaptation.All treatments allowed a lower droppings oocyst excretion that non supplemented feed and excretion beacame very low after 42 days of age.

Nutrition has to do with coccidiosis control (Crevieu-Gabriel and Naciri, 2001) as it can change gut mucosa development, immune system responses and possibly a direct action on parasite. The physical form of feed and the way it's fed are also involved as whole wheat grain is found to be generally detrimental (Gabriel et al 2003). As well known, coccidiosis reduces amino acid rate of absorption , disturbs water,carbohydrate, fat , pigments and mineral digestion that further reflects on intake and growth rate.

Conclusions

Alternative poultry doen't seem to have many basic nutrition specificities that requires further research attention but it's their interactions into feeding program and genetic potential that raise scientific questions on 4 areas.

- improve maintenance requirements knowledge to allow growth and body composition prediction of SG and MG breeds and crosses. Approaches through implementation of models like INAVI that takes on board activity and breed specificities are relevant to that target.
- address the environnemental negative impact of alternative chicks against standard ones through eco-friendly additives use and phase feeding and/or alternative free choice feeding .This is part of an integrated approach at the farm level and needs scientific background to allow certification of the environnemental benefit that customer or governments can trust and pay a premium for.
- rationnaly use the emotional « natural » feeding and free choice of feed for the chick tojustify energy and protein separate feeding for a continous adjustment to chicken volontary needs, and more sophisticated energy feed design may be more effective as the whole grain and the proteic balancer
- health/nutrition interactions are under research for broilers and certainly could be adapted to longer growth periods for alternative one's. Starter nutritionnal and physical form design research have a future for gut and it's parasite parallel control

Past of alternative chicken in France was linked with an acceptance of higher meat quality and certified mode of farming, organic farming a much less convincing, but we can see a plateau of production that warns us of a higher importance of cost in consumers choices. Carcass extra value of 1.25x FG birds for MG and 1.65 for SG birds obtained in France are probably a higher limit for market avlue, even with the processed parts market.
A study at Spelderholt Institute (Van Harn et al 20001) has concluded that MG chicks cost of production was some 8,5 to 10% higher than a Ross 508 although fine tune feeding was not looked at and could be accepted by a large part of consumers but may be not by cut part buyers.
Outside EU we can see that alternative chicken in countries like Brasil is of interest (Farina and al , 2003) but on a much larger scale as in the US whereit seems to aim at small or very small operations of sustainable farming (Tablante ,2003) or even home « tractor chicken » or « pastured pens » back yard production.
EU farmers have to work on a more economical approach of alternative poultry and build a convincing marketing if they don't want to see these alternative poultry market also challenged by imports and the new 10 members agriculture may have there an opportunity.

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