Swedish University of Agricultural Sciences
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How strain and production system effects chicken welfare and quality in meat; a literature review

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Hur genotyp och produktionssystem påverkar kycklingars välfärd och köttkvalitet; en litteraturöversikt

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Abstract

There are several reasons why organic chicken production is scarce in Sweden. Lack of slow growing (SG) strains combined with higher production costs, lower meat-yield and uncertainty of consumers' willingness to pay seems to be the main reasons. EU-legislations imply use of indigenous slow- or medium growing strains in organic production, nevertheless, fast growing (FG) broilers are often used due to their effectiveness. Increased consumption of processed food creates a market for conventionally rearing of very heavy broilers. Through selection programs FG broilers gain weight fast leading to inactivity, imbalanced bodies, disease and high mortality rates. This combined with legislations by KRAV regarding daily growth and slaughter age make FG broilers used in organic production questionable. SG strains adapt well and benefit from extensive conditions and increased motion whilst FG broilers cannot fully use outdoor areas. In organic production, FG broilers have significantly higher mortality rates than medium and SG chickens. Quality of chicken meat is mainly afflicted by genotype, maturity, sex and production system. Related to age, meat from SG strains contains more protein and half as much intramuscular fat than meat from FG broilers. For several years, FG broiler meat qualities have been based on offering consumers' cheap meat. Consumers' today are more concerned about animal-welfare than in the past and the market for extensive produced poultry are growing.

Sammanfattning

Det finns flera orsaker till varför den ekologiska kycklingproduktionen i Sverige är liten. De viktigaste anledningarna är brist på långsamväxande raser, höga produktionskostnader och ekonomisk osäkerhet. Trots att lagar på EU-nivå hänvisar långsamväxande raser till extensiv produktion används snabbväxande hybrider på grund av deras effektivitet. Konsumtionen av halvfabrikat ökar och i takt med det växer marknaden för stora slaktkroppar. Selektion för snabb tillväxt har orsakat inaktivitet, obalanserade kroppar, sjukdom och hög dödlighet hos broilers, detta i kombination med KRAV:s regler angående daglig tillväxt och slaktålder gör att användning av broilers i ekologisk produktion kan ifrågasättas. Långsamväxande raser är väl anpassade till och drar nytta av extensiva förhållanden, snabbväxande hybrider kan inte utnyttja utomhusvistelse lika väl som de långsamväxande raser. Snabbväxande kycklingar har signifikant högre dödlighet i ekologisk produktion än långsamväxande. Köttkvaliteten påverkas framförallt av genotyp, köttmognad, kön och produktionssystem. Kött från långsamväxande raser innehåller mer protein och hälften så mycket intramuskulärt fett än kött från snabbväxande hybrider. Kycklingkött har tidigare värderats som en billig proteinkälla men konsumenter värdesätter mer och mer en förbättrad djurvälfärd och köttkvalitet vilket ökar marknaden för ekologiskt producerad kyckling.

Introduction

As consumers' wealth and living conditions improve, their demands for good food safety, animal welfare and production methods increase. However, price will continue to be the crucial factor for purchasing chicken meat (Muir & Aggrey, 2003). Only a small part of

produced chicken[1] meat in Sweden is organic, despite the increasing demand for organically produced meat (Blair, 2008). There is no national breeding program for meat-producing chickens in Sweden, financial risks and regulations regarding organic production seem to be the main reasons (Bassler, 2008). Fast growing (FG) broilers[2] are used both in conventional and organic production (Waldenstedt, 2005). A few international companies provide FG broilers to the world, parents of the chickens in Sweden are imported from the United Kingdom. Absence of slow growing (SG) strains can be explained by lack of SG parents (Bassler, 2008), combined with national quarantine-rules that makes it impossible to import SG day-old chickens to Sweden (Waldenstedt, 2005). The organic producers' only choice seems to be the FG broilers that are delivered by commercial companies (Waldenstedt, 2005) to Swedish hatcheries.

The modern FG broilers are produced for a conventional production (Blair, 2008). Commercial breeding for growth and high breast meat-yield started in the 20th century, resulting in quadrupled growth rate, leading to inactivity, imbalanced bodies, disease and high mortality rates (Muir & Aggrey, 2003). These qualities combined with legislations by KRAV regarding daily growth and slaughter age make FG broilers used in organic production questionable (Waldenstedt, 2005). Behaviours like cannibalism, increased pluming and search for food indicates that FG broilers with restricted diets, in order to decrease growth, suffer from hunger (Eriksson, 2010). SG strains are used in organic production in some European countries. Both rearing period and nutritional content of the meat differs from FG broilers (Waldenstedt, 2005). Aspects such as genetics, age, sex and production system affects the quality of all chicken meat (Fanatico et al., 2007). The aim of this review is to investigate the possible advantages and disadvantages with using FG or SG chickens in an organic production and how meat quality is affected by different strains and production systems.

EU-legislation and KRAV

The organic chicken production in Sweden is regulated by EU-legislations, IFOAM (International Federation of Organic Agriculture Movements) and additionally by KRAV. Changing from conventional to organic production entail several legislations to consider (Swedish board of agriculture, 2005). EU-legislations imply the use of indigenous slow- or medium growing strains in organic production, nevertheless, FG broilers are often used due to their effectiveness (Grashorn, 2006; Sirri et al., 2010). Due to EU-legislations the animals used in organic production should to be bred organically. There is only one farm in England where FG broilers are bred organically (Swedish board of agriculture, 2005).

KRAV is a Swedish economic association (KRAV, 2013a), accredited by IFOAM (Swedish board of agriculture, 2005). KRAV defines SG strains as birds that grow maximum 50 gram/ day, with a minimum rearing period of 81 days (KRAV, 2013a). It is allowed to buy conventionally hatched FG broilers and rear them in organic production (Swedish board of agriculture, 2005). According to KRAV:s regulation it is allowed to keep chickens indoors

[1] Chicken= All types of chickens
[2] Broiler= Fast growing hybrids

until 30 days of age, offering space of maximum 10 birds and 20kg/ m^2 and containing maximum 4800 chickens per section. The birds should have access to sand bathing areas, perches and outside space with pasture of a maximum of four birds/ m^2 during summer. Chickens must have at least eight hours without artificial light in the night and preventive use of coccidistats is not allowed (KRAV, 2013a). In order to gain an organic label, chickens must be slaughtered in a slaughterhouse approved by KRAV (Swedish board of agriculture, 2005).

Organic and conventional production systems

There are big differences between conventional and organic production systems in Sweden. Conventional production includes large stationary buildings, high stocking density and ad libitum diets containing synthetic amino acids. Organic production involves restricted organic diets without synthetic amino acids (AA), outdoors access and no parasite preventing additives (KRAV, 2013a). The most essential AA in birds are methionine and cysteine. It is a challenge to produce organic diets with valid amounts of these substances.

Conventional production

Broilers in conventional production reach market weight at five to six weeks. Thorough selection programs they grow fast and gain high breast meat yields. They have been selected for conventional indoor production where ambient factors are well controlled. These factors make them poorly suited for organic production (Fanatico et al., 2007), because of the lowered immune system and decreased conformability to shifting outside temperatures. High stocking density interferes with chickens resting and motion abilities resulting in impaired leg health, along with increased age it also increases heat stress (De Jong et al, 2012). Conventionally reared FG chickens weigh about two kg at 35 days of age, at 81 days they weigh between four to six kg. SG chickens at 56 and 77 days of age weigh about two kg respectively three kg (Bassler, 2008).

Organic production in Sweden

Only 0,1% of produced chicken in Sweden is organic, in contrary, the demand for organic chicken is 1-2% of the total production (Swedish board of agriculture, 2013). Freshly sold organic chicken increased with 3% between 2011 and 2013. This increased demand for organic animal products indicates consumers' value of animal welfare (KRAV, 2013b). It also indicates room for a big increase of the organic production (Swedish board of agriculture, 2013). According to assorted groceries and restaurants in Sweden it is, in relation to conventional food, possible to raise prices for organic food with a maximum of 30 % (Swedish board of agriculture, 2005). Organic chicken production in Sweden is small compared to organically produced beef, depending on big differences between organic and conventional production systems for monogastric animals. The economic compensation from the government is not adjusted for animals with cereal-based diets. Almost all grain-fields in Sweden are produced with chemicals and an increased organic chicken production is depending on organic crops (Swedish Government, 2010). Other factors that obstruct the organic production in Sweden are big slaughterhouses that have problem dealing with small flocks of extensively reared chicks. Also unwillingness to invest due to economic uncertainty

along with high production costs and in availability of SG hybrids seems to influence the extent of organic chicken production (Swedish board of agriculture, 2013).

Organic production in Europe

The approach to organic production in terms of a good environmental and animal friendly production system is comparable in different countries (Blair, 2008). However, when comparing organic and conventional production, the concept of animal welfare does not include the same matters (Tuyttens et al., 2008). Research shows a globally increased demand for organic food due to awareness of environmental factors and health aspects (Blair, 2008). There are several names for organic production within the European Union (EU); organic, ecological and biological are frequently used terms. Some of the initial ideas of how organic production should be practiced have been changed, for example synthetic vitamins and AA have become allowed due to the lack of organic alternatives. There are some countries, Sweden for example, that do not allow these supplements (Blair, 2008) according to national legislations.

The fast growing broiler

FG broilers in conventional production

The increased consumption of processed food creates a market for rearing very heavy broilers. By delaying the time of slaughter, the longevity doubles and produced meat is tripled (Baéza et al., 2012). Rearing FG hybrids up to 63 days of age to get maximum meat output increases profit, on the contrary, an increased death rate after 49 days of age contributes to economical losses (Baéza et al., 2012). Due to added costs in term of fodder and extended rearing time, a slaughter age of 42 days is the optimum for a financial gain (Baéza et al., 2012). There are several problems with prolonged rearing of FG broilers, both regarding animal welfare in term of walking ability and environmental aspects in form of increased amounts of manures. The quantity of N and P per meat output is almost redoubled when increasing the age of slaughter from 35 to 63 days of age, this also effect animal welfare as increased humidity in litter in stables enhance risk of dermatitis (Baéza et al., 2012). A study made in 2002 showed that 100% of chickens reared to 63 days of age in a conventional system suffer from dermatitis and that severe gait problems seem to appear after 35 days of age (Baéza et al., 2012). In addition to growth rate and genetic background, extended lightening programmes further lower broilers activity and increase sedentary behaviour (Bessei, 2006). Broiler parents need severe feed restrictions in order to prevent obesity, which would make them unable to reproduce. The result is hunger and stress. Mating ability is also affected; lowered fertility and aggression between sexes occur (Muir & Aggrey, 2003 s. 76).

FG broilers in organic production

FG broilers in organic production in Sweden must be reared in a total of 81 days, but because they are not meant to live this long, chickens get too heavy and the risk of heart- and bone-diseases increase (Swedish board of agriculture, 2005). Broilers are afflicted by various conditions like reduced behavioural activity, skeletal dysfunction, footpad necrosis and hock burns. Selection for increased growth affect broilers conformability regarding environmental changes (Muir & Aggrey, 2003 s. 76). Feed restricted low nutrient diets are used to decrease

growth in organically reared broilers. Decrease of crude protein and amino acids leads to increased movement but also bone weakness, cannibalism and behavioural changes such as increased feather trimming and food searching - indicating hunger (Eriksson, 2010). High weight and decreased mobility cause increase in pluming for FG broilers, a possible behaviour disorder due to inactivity (Bokkers & Koene, 2003). Diet and brooding process in young chickens may affect ascites later in life (De Jong et al., 2012). FG chickens over eight weeks of age spend only 1% of the time walking (percent of the time spent observing the chickens in the experiment). Even though feed-restricted broilers weigh half as much as broilers fed ad libitum, the time they spend resting is similar. Behaviour and physical disorders is not correlated, which indicates that the increased resting behaviour is genetically regulated and not because of diseases (Bokkers & Koene, 2003).

Slow growing strains

It is known that indigenous dual-purpose hens are one of the world's most common domestic animals, and are very important in the poor parts of the world. They produce important protein in form of meat and egg and are often held extensively in backyards where they are fed leftovers or find their own food. The dual-purpose idea can be applied in the egg producing industry. Roosters from egg-type strains can be used as an asset, instead of being euthanized at hatch, if reared for meat production (Sirri et al., 2010). These roosters have even lower growth rate than SG meat-chicken strains but higher meat quality in terms of colour and taste (Lichovníková et al., 2009).

Organic chicken production has been established in France since 1960. It started when consumers requested improved meat-quality than that of FG hybrids. The result was a new chicken, ISA 657, with flavourful meat, produced by a French breeding-company called ISA-Hubbard. The production, Label Rouge, is successful and owned by the state. ISA 657 is used in other countries as well, for example Denmark (Swedish board of agriculture, 2005). These birds reach 2.25 kg in 12 weeks and have minimal health-problems and strong immunity (Yang and Jiang, 2005). There are two large international companies providing SG chicken strains, Hubbard-Isa and Sasso (Grashorn, 2006).

The type of meat produced from SG strains better meet with consumers' expectations of organically produced chicken in terms of size and nutritive content (Sirri et al., 2010). There is no interest of high growth rate of chickens in organic production due to increased slaughter age and market demands (Lichovníková et al., 2009). Organically reared SG strains need 120 days, instead of 81 days for FG broilers, to attain accepted slaughter weight (>2 kg), time differences in growth are genetically regulated (Castellini et al., 2002a).

The FG broilers Ross and Cobb were used in most of the reviewed articles. Whereas for the SG strains, different breeds was used; naked-neck chickens, provided by Sasso breeding company in France (Chabault et al., 2012, Sirri et al., 2010); a SG broiler ISA 657 from Hubbard ISA chickens (Williams et al., 2013, Nielsen, 2012); leghorn-males from an egg-laying strain (Olkowski et al., 1999), mos, a local breed in spain (Franco et al., 2013); robusta maculata, an Italian breed (Castellini et al., 2002a). Using SG strains instead of FG with

restricted diets to accomplish lower growth is more efficient to elude bone- and metabolic diseases (Bessei, 2006).

Diseases

Disease in FG broilers in conventional production cause financial losses, one considerable complaint is ascites. SG chickens and feed restricted FG broilers have significantly higher heart rate than broilers fed *ad libitum* at 35 days of age. Birds with ascites have additionally lower heart rate than healthy birds (Olkowski et al., 1999). FG broilers have significantly higher mortality rates than medium and slow growing strains (12%, 9% and 4% respectively) (Castellini et al., 2002a). FG broilers have problems with pododermatitis due to high body-weight and weak bones. Infection of campylobacter, which also seems to increase hock marks and make excrement drippier, contributes as well (Williams et al., 2013). Inactive chickens laying on litter of poor quality is afflicted by breast and hock irritations while those that stand up a lot get more footpad problems (Bestman et al., 2011 pp 81). FG broilers cannot fully use outdoor areas and show an imbalanced growth in muscles (Castellini et al., 2002b). Increased movement is positive for leg-health in FG broilers but it also increases their heat production. To regulate high temperature they are forced to adapt their behaviour, leading to inactivity. On the contrary, SG strains use metabolic changes to adapt to new temperatures (Nielsen, 2012), they adapt well and benefits from extensive conditions and increased motion (Castellini et al., 2002b).

Meat quality

Quality of chicken meat is, amongst other factors, afflicted by genotype, maturity, sex, production system, stocking density and ambient temperature (Fanatico et al., 2007). Variations in nutritive content in meat between breeds are mainly influenced by genotype and production system, diets have little impact (Fanatico et al., 2007) other than on growth rate (Grashorn, 2006). Taste and aroma is mainly affected by fatty acid content in meat (Yang & Jiang, 2005). Carcass yield, breast meat and live weight are mainly regulated by genetics (Grashorn, 2006). Colour of meat from birds of different breeds with different diets is more influenced by sex than other aspects; meat from hens being slightly redder (Grashorn, 2006). Related to age, meat from SG strains contains more protein than meat from FG broilers (Fanatico et al., 2007). Organically reared FG broilers have a lower growth rate and a defective feed efficiency but less abdominal fat and a higher rate of breast and drumstick, than conventionally reared ones (Castellini et al., 2002b).

Fat-content

The minimum of 81 days rearing period, according to the European organic farming regulation, makes FG broilers very heavy and with high content of lipids, despite regulated feed intake. Only breast meat from organically reared FG broilers can be sold as organic while the rest being sold as conventional meat (Blair, 2008), due to the large size (Sirri et al., 2010). However, organically reared FG broilers are more active then conventionally reared ones, which increase muscle mass and decrease abdominal fat, they are also more stress resistant (Castellini et al., 2002b). SG strains generally show higher content of fat, due to higher slaughter age (Grashorn, 2006). Even so, SG strains contain half as much

intramuscular fat as FG broilers. SG strains tend to deposit fat in the abdomen or under the skin, which leads to low fat in meat (Fanatico et al., 2007). Meat from SG strains contain higher amount of polyunsaturated fatty acids (PUFA) (especially omega-3) and lower fat content, than FG broiler meat. High-energy conventional diets lead to higher fat content in meat than organic diets (Fanatico et al., 2007). However, some studies show that the variety in fatty acid compounds between breeds seems to be effected by genotype, not diet (Sirri et al., 2010).

Effect of outdoor access and gender

Due to grazing, organically reared SG strains develop yellow meat and skin. The same do not apply to FG broilers under the same conditions (Fanatico et al., 2007). Meat from SG strains reared indoors contains more fat and less protein than chickens kept outdoors, due to increased muscle activity in outdoors areas (Fanatico et al., 2007). Meat from SG strains with outdoor access show lower pH than if kept indoor, on the other hand, pH in FG broiler meat is not affected by outdoor access (Fanatico et al., 2007). SG strains in extensive rearing also have more tender meat than FG broilers and intensive production (Fanatico et al., 2007).

Sex affects the meat composition in SG strains like Label Rouge. Males are heavier from three weeks of age and get less fatty meat than females; the effective growth rate makes meat from roosters more suitable to be sold as cuts (Chabault et al., 2012). PH, water- holding capacity and colour of the meat are genetically correlated and heritable within strains. Growth rate, body composition and quality traits are heritable as well but genetic correlations varies between the sexes (Chabault et al., 2012).

Cooking-loss and shelf life

Different factors affect quality of meat; a high cook loss indicates poor water holding capacity (WHC). Small muscles have higher WHC while big muscles have more thaw loss and higher fat content, resulting in more water loss when heated. Smaller muscles imply less thaw and cook loss (Fanatico et al., 2007). Breast-fillet from organically produced broilers tends to get bigger due to increased slaughter-age and exercise (Blair, 2008) and meat from FG broilers therefore have a higher grilling loss (Grashorn, 2006). However, some studies show the opposite where meat from SG strains have higher cook losses and about 10% less carcass yield than FG broilers. This indicates that heavy carcasses from FG broilers do not suit the market of organic chicken (Sirri et al., 2010). SG strains mature slowly, the result of low matured meat is high liquid content and low protein values, possibly resulting in increased cooking losses. This does not seem to affect the tenderness of the meat (Castellini et al., 2002a).

Several factors affect shelf life in chicken meat, for example oxidative processes and pH. SG strains in organic production graze more efficiently than FG broilers. This leads to higher antioxidant capacity in the meat, resulting in shorter shelf life. A high oxidative process suggests that storing and selling whole carcasses is most beneficial for SG strains (Castellini et al., 2002b). Rearing FG broilers in organic production leads to increased activity which in turn lower oxidative stability in meat. Increased acidification due to higher glycolytic energy metabolism is associated with a high body weight (Castellini et al., 2002b). Low pH

associates with short shelf life (Fanatico et al., 2007) and meat from FG Ross, compared to SG breeds has low pH value resulting in lighter colour, lower oxidative processes and low iron content (Castellini et al., 2002a).

Consumers' opinion

For a long time, FG broiler meat qualities have been based on safety, nutritional values and to offer consumers a cheap high protein product. Due to the low production-cost, chicken meat it is considerably cheaper than beef and pork. Consumers today are more concerned about animal-welfare than in the past and the market for extensive produced poultry are growing (Muir & Aggrey, 2003), the consumers opinion on taste and appearance of FG broilers in conventional or organic production is that there is no real difference in taste (Blair, 2008).

Summary; meat Qualities

Meat qualities of FG broilers and SG male egg-type chickens slaughtered at 84 respectively 96 days of age reared in organic production (Sirri et al., 2010)

Trait	SG	FG
BW (g)	1807	5198
% Breast[A]	8.0	20.7
% T&D[B]	21.6	22.0
% Meat yield[C]	56.8	69.2
% Lipid[D]	0.98	1.27
% Pufa[E]	43.14	31.87
% Mufa[F]	22.82	34.4
pH[G]	5.78	5.79
% Cook loss[H]	31.44	25.7

BW= bodyweight, [A]= Percent of breast muscle in live weight, [B]= Percent thigh and drumstick in live weight, [C]= Meat yield (carcass/BW), [D]= Percent lipid in breast meat, [E]= Percent of polyunsaturated fatty acids in breast meat (% of total fatty acids), [F]= Percent of monounsaturated fatty acids in breast meat (% of total fatty acids), [G]= pH value in breast muscle, [H]= Cook-loss in breast meat.

Discussion and conclusion

Several aspects promote the use of SG strains in organic production. The meat is healthier than meat from FG broilers (Sirri et al., 2010). Using restricted diets in order to stunt growth and prolong rearing period in FG broilers result in risk of decreased welfare of the birds, rearing SG strains and optimizing diets regarding high protein values can be a solution to the problem. However, increased protein in diets leads to increase in N leaking out, which is in direct contrast to organic environmental goals (Eriksson, 2010). SG strains are unsuitable for processed products, but are beneficial to produce flavourful meat. Consumers value drumsticks and thigh-meat most and the proportion of these parts in relation to the whole chicken have economic value. A higher percentage of desirable parts can make a SG strain more valuable than FG broilers (Franco et al., 2013). The inefficiency of SG strains is outweighed by premium prices and nutritional aspects (Fanatico et al., 2007), such as low fat content. The fact that only breast meat from organically reared FG broilers can be sold as organic while the rest being sold as conventional meat contradicts the economic aspect of

choice of FG broilers in organic production. Despite longer rearing period, the 30 % extra income from selling whole carcasses from SG strains would be clearly beneficial. The price of organic chicken meat is too high to be affordable for all consumers, all the same, there is a lack of organic chicken products in stores (Blair, 2008).

Consumers in Sweden are probably getting used to the lack of taste and colour of meat from FG broilers, and value it as a cheap protein source. Food culture plays a big role in France where the red label production is a big part of the total chicken production. Meat quality such as taste and colour is what markets the Red Label business. There seems to be several reasons why organic chicken production is scarce in Sweden. Lack of SG strains combined with higher production costs, lower meat-yield and uncertainty of consumers' willingness to pay more seems to be the prime reasons why FG broilers are being used in organic production, despite opposed recommendations from EU-legislations. Introduction of SG strains depends on investments from big companies (Bassler, 2008). The organic producers only choice are FG broilers delivered by big companies (Waldenstedt, 2005), or taking the risk of investing in an own breeding program with SG strains. It is possible to breed your own chickens, and thereby get a SG strain but it comes with financial risks (Swedish board of agriculture, 2013).

There is an overconsumption of meat in wealthy countries like Sweden, which probably depends on low prices as a result of industrialization of the meat industry. However, it is on the expense of meat quality and animal welfare. By information of health aspects of organic food in combination with reduced everyday meat intake, this food culture might be changed without need for consumers to pay more for healthier and tastier food. Overconsumption will decrease and quality will increase. To accomplish this, it is essential that farmers who invest in organic production and SG strains feel economically supported by the government. It would also be necessary to have animal welfare and environmental aspects of the food industry as a natural part of every child's education. Consumers today are more concerned about animal-welfare than in the past and the market for extensive produced poultry are growing (Muir & Aggrey, 2003), the opinion on taste and appearance of FG broilers in conventional or organic production is that there is no real difference in taste (Blair, 2008), this further indicates the benefits of using SG strains with more flavourful meat. Regarding meat quality, meat from SG strains contains less total fat content and more polyunsaturated fat than FG broilers, which is both healthier and taste more.

Some of the legislations by KRAV seem to be contra productive in terms of increasing the organic chicken production. In order to get organically labelled, chickens must be slaughtered in a KRAV approved slaughterhouse, organic producers in Sweden therefore need to adapt their location to those or build their own slaughterhouse (Swedish board of agriculture, 2005). Approved slaughterhouses should get subsidized to promote production. To avoid the use of FG broilers in organic production, and the animal welfare problems connected to that, KRAVs definition of SG chickens will need to change. Not allowing feed restricted diets as a solution to get broilers to grow slow would be essential. Restricted diets leads to hunger and in turn animal welfare issues such as cannibalism, which does not meet consumers' expectations of organically produced meat. A potential solution could be if the government invest in hatcheries providing SG strains in order to support the production.

Quality and taste of meat depends on genetics, using feed restricted FG broilers in organic production does not make their meat even comparable to meat from SG strains in term of quality. The production of SG strains should not be compared to FG broilers in term of effectiveness but should solely be based on the market demand for healthy food and priced as a high quality product. Roosters from egg-laying strains can therefore be used as a meat-producing asset instead of suppressed at hatching (Sirri et al., 2010).

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