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Food safety and environmental issues in animal welfare

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Summary

Food safety, protection of the environment and animal welfare are three concerns consumers have about modern food production systems. Standards dealing with these three issues can be in conflict, and finding ways to reduce this conflict is essential as international standards governing animal welfare develop. These conflicts can be reduced if flexible animal welfare standards are animal-based and attempt to directly assess the state of the animals themselves rather than prescribing the conditions under which the animals are reared. Animal welfare is often treated as an ethical issue, and is therefore difficult to deal with under current trade agreements. A greater appreciation of the link between animal welfare and animal health makes the link with food safety clearer. Improvements in animal welfare have the potential to reduce on-farm risks to food safety, principally through reduced stress-induced immunosuppression, reduced incidence of infectious disease on farms and reduced shedding of human pathogens by farm animals, and through reduced antibiotic use and antibiotic resistance. Health problems of farm animals continue to be serious threats to animal welfare, and measures of disease incidence can serve as animal-based measures of animal welfare. Continued development of hazard analysis and critical control point-based approaches to animal welfare would allow a smoother integration of animal welfare and food safety standards.

Keywords

Animal health – Animal welfare – Environment – Food safety – Hazard analysis and critical control point – Immunosuppression – Stress.

Introduction

Food safety, protection of the environment and animal welfare are three concerns consumers have about modern food production systems (9). In many people's minds these three are linked; there is a common assumption that improved animal-rearing methods will simultaneously result in better and safer food, reduced environmental problems and better animal welfare. Indeed, some of the public's expressed concern about animal welfare may be based on the perceived link with food safety (4). Furthermore, animal welfare, environmental protection and food safety are being linked in the various government agricultural policies and retailer and producer quality-assurance schemes that are currently proliferating (1). There is some scientific support for this link: in this paper, the authors show many of the ways that improvements in animal welfare can enhance food safety and reduce environmental problems. However, in some cases, the three concerns can appear to be incompatible (34). This is most worrying at the regulatory level, where regulations set up to improve food safety or protect the environment risk having a negative impact on animal welfare, and vice versa.

Finding ways to reduce the conflict between regulations or standards governing animal welfare, food safety and environmental protection is essential as international standards governing animal welfare begin to develop. The authors argue that these conflicts can be reduced by

modifying the way in which animal welfare issues are approached. If animal welfare standards are based solely on design or engineering criteria, then there is increased risk that any conflict with food safety and environmental regulations will be resolved to the detriment of one of these issues, most probably animal welfare. However, while not preventing conflict entirely, animal welfare standards involving animal-based measures provide more flexibility in ensuring that improvements in animal welfare can occur alongside improvements in food safety and environmental protection.

Conflict between standards dealing with environmental issues, animal welfare and animal health

Regulations or standards developed to deal with food safety or environmental issues can have a direct impact on animal welfare and vice versa. In some cases the standards can benefit all three aspects, promoting animal welfare, food safety and environmental protection at the same time. Unfortunately, the impact can also be negative, creating a potential conflict between regulatory aims. A few examples of this will suffice. In some European Union (EU) countries, legislation has been passed or is being considered to reduce the use of fully slatted flooring in pig houses, principally because of the effect of these types of floors on animal welfare. However, slatted floors can reduce the incidence of *Salmonella* infections among growing pigs (24) and may help reduce ammonia emissions from pig barns (23). In Canada, some jurisdictions are limiting the access grazing cattle have to natural water sources to prevent water contamination. This, however, may limit the cattle's access to fresh, clean drinking water and to shade (since trees are often found close to streams), and both these restrictions may reduce animal welfare, especially when they are combined. Bans on use of antibiotics as growth promoters, while reducing the chance of antibiotic residues in food, may increase the incidence of certain gastro-intestinal diseases among pigs (6).

However, while some conflict may be expected, not all of the presumed negative impacts inevitably occur. For example, it is often assumed that aviary or free-range housing for laying hens may increase the chance of faecal contamination of eggs. However, one study has found that increased use of free-range eggs appears to be associated with a reduced risk of *Salmonella*-based food poisoning (26). There were fears that the reduction in use of antibiotics both for treating and preventing disease, which was required under standards governing organic agriculture, would lead to an increase in health problems of animals. In general, that does not seem to have occurred, although there are some specific situations where organic standards have resulted in an increased incidence of health problems (14, 38). As a final example, outdoor housing of pigs, if well managed, does not necessarily result in greater environmental impact than indoor housing, as is often feared (13).

Nevertheless, there is a tendency to assume that food safety and environmental concerns are more important than animal welfare issues and that the latter may be sacrificed to ensure the former (34). Certainly, consumer surveys support the primacy of food safety issues (12, 40). However, the authors argue that much of the conflict arises because of the way that animal welfare standards are phrased and that a greater use of animal-based standards may help reduce this conflict. There is increasing pressure to harmonise food safety, environmental and animal welfare standards in the context of international trade (1). Consequently, it is important to ensure that animal welfare standards are developed in a way that will ensure that they are consistent with on-farm food safety and environmental standards (34).

Consumer perceptions of a link

Consumer choices of food are often based on a perception that good animal welfare, protection of the environment and good food safety tend to go together. Some of the public's concern about animal welfare may be based on the assumption that good animal welfare improves food safety (4). Surveys undertaken in the EU show that consumers often state that animal welfare issues are important to them in making purchasing decisions, although sometimes these are of secondary importance compared to food safety, taste and nutrition. Sub-groups of consumers are emerging who are concerned with a range of 'civic' issues, including animal welfare along with environmental concerns, and these concerns can influence purchasing decisions for this (sometimes sizeable) segment of the population (40). This has led to the development of a number of marketing schemes aimed at niche-markets. Some of these schemes have been developed specifically for farms that meet high standards of animal welfare. The most successful international example is the Freedom Food label developed by the Royal Society for the Prevention of Cruelty to Animals (RSPCA) in the United Kingdom (UK). However, the market associated with organic animal agriculture is probably of greatest economic importance, and the consumers' perception of a link between food safety, environmental issues and animal welfare is most apparent in this context. The primary interest of

consumers in organic agriculture relates to supposed beneficial effects on the environment or health, through reduced use of medication, pesticides and fertilisers. However, animal welfare issues are also clearly important: the majority of the codes or regulations that deal with organic animal production include specific standards dealing with animal welfare (14, 39). Furthermore, concern about animal welfare issues appears to be one of the reasons why consumers do buy organic animal products, especially in the UK (12, 13). Consumers of organic animal products appear to place a premium on high levels of animal welfare. However, it is clear that compliance with standards for organic agriculture does not inevitably improve either animal health or animal welfare (14) or reduce environmental impact (3). Von Borell and Sorensen (39) argue that standards for organic agriculture need to be supplemented with on-farm animal welfare schemes based on animal-based measures (discussed below).

Although consumers often perceive food safety and animal welfare as linked, in some cases the two issues can become dissociated: some consumers view poultry meat as being 'healthier' than beef or pork (mainly due to the belief that it contains less fat and fewer 'harmful substances'), while they judge the welfare of poultry as being lower (36).

Animal health and animal welfare

Animal welfare is often treated primarily as an ethical issue, but there are difficulties dealing with ethical issues under current international trade agreements (5). However, a greater appreciation of the link between animal welfare and animal health makes the link with food safety clearer. Baines and Davies (1) argue that animal welfare issues should only be considered in international standards for food safety to the extent that the issues do have an impact on food safety. This view was reflected in a recent report published for the European Commission (7), which emphasised the importance of maintaining animal welfare standards within the EU's food safety policy. The underlying reason given was the clear link between poor animal welfare and reduced animal health and lower food safety. The report argued that on-farm monitoring of animal welfare was essential to ensure food safety. In order to avoid the perception that animal welfare standards were simply a tool for protectionism, and to promote the view that animal welfare standards are an essential step in maintaining food safety, the report stressed the need to develop an international consensus on animal welfare standards and the need for greater scientific research examining the link between animal welfare and food safety.

Direct evidence of a link between animal health and animal welfare

The link between animal welfare and animal health (and hence, by implication, food safety) is supported by scientific evidence. There are close links between good animal welfare and good animal health. Hence improvements in animal welfare have the potential to reduce on-farm risks to food safety, principally through:

– reduced stress-induced immunosuppression

– reduced incidence of infectious disease on farms and reduced shedding of human pathogens by farm animals

– reduced antibiotic use and antibiotic resistance.

Stress and immunosuppression

There is now ample evidence that the endocrine changes that occur when animals are stressed can have marked effects on the immune system. Although stress can enhance as well as inhibit the immune system (31), the bulk of the evidence suggests that chronic or prolonged stress generally inhibits the immune response to infection, thus potentially rendering animals more susceptible to infectious disease. Thus, challenges to animal welfare that are sufficiently strong to provoke chronic physiological stress responses may contribute to a higher incidence of animal disease. This can affect food safety both through an increased risk of bacterial contamination of food and through a greater risk of antibiotic residues in food.

As yet, there are few clear demonstrations of stress-induced immunosuppression leading to a greater incidence of illness. However, the stress associated with transport and arrival of beef cattle at feedlots has long been implicated as a causative factor in the high incidence of respiratory disease that results (21). Early weaning of piglets, a major animal welfare concern, has been found to lead to some signs of immunosuppression: namely, a reduced proliferation of lymphocytes to a mitogen, and increased signs of illness in piglets exposed to bacterial toxins (16).

Poor welfare, increased incidence of disease and increased bacterial shedding

There are several examples of how housing systems associated with better animal welfare may also be associated with better animal health. For example, dairy cows provided with greater opportunities for exercise require less medication (27). A major source of welfare problems comes from the high stocking densities that are

often used in intensive animal husbandry, and animal welfare regulations or standards often seek to place some limits on the stocking densities that can be used. As well as reducing animal welfare, overcrowding – either through a space allowance that is too low or group sizes that are too large – increases the risk of disease within groups of animals, or can be an indirect risk factor for poor food quality. For example, an increased mortality rate and greater incidence of respiratory disease were found when dairy calves were housed in large groups (19).

Furthermore, high stocking densities can increase the shedding of *Escherichia coli* O157 in beef feedlots (32). There is considerable evidence that stress can increase faecal shedding of bacteria by infected animals. Various stressors (weaning, cold, mixing of litters) can increase faecal shedding of *E. coli* by pigs (15), and muddy pens in feed lots increases *E. coli* shedding in cattle (32, 33). Thus improvements in housing conditions that enhance animal welfare may reduce the risk of disease transmission by reducing bacterial shedding. Stress associated with transport and lairage before slaughter increases shedding of *Salmonella* by cattle (2) and pigs (17) at abattoirs, and thus, reducing stress at transport and prior to slaughter may directly reduce the risks of food contamination.

Improved welfare, reduced antibiotic use and antibiotic resistance

Many of the more serious welfare problems affecting farm animals are associated with an increased use of antibiotics. For beef cattle, a major risk to welfare occurs following transport and arrival at the feedlot. The most prevalent illness associated with the arrival of cattle at the feedlot is acute respiratory disease complex. Such respiratory disease is a major cause of death among newly arrived feedlot cattle (18) and the occurrence of such diseases is the major cause of antibiotic use on feedlots in the United States of America (35). Finding means to control the incidence of shipping fever would greatly improve animal welfare and reduce antibiotic use.

There is some documented evidence that improvements in animal welfare can help reduce the use of antibiotics. A recent study in Switzerland found a reduced occurrence of antibiotic resistance in *Campylobacter* spp. isolated from the faeces of piglets raised in 'animal welfare friendly' systems (which involved higher space allowances, straw bedding and an exercise yard) compared with more conventional rearing systems (28). It is not clear if this resulted from a higher level of animal health, or from a reduced use of antibiotics by farmers who opted for the welfare-friendly systems. However, this is the first empirical evidence that improvements in animal welfare may be associated with reduced antibiotic resistance in bacteria.

Animal welfare and environmental problems

Links between animal welfare and environmental issues have been less explored than the links with food safety. The high stocking densities used in indoor housing are often a cause of welfare problems, and are also responsible for much of the air pollution associated with this type of housing (11). The high levels of gases and dust often found in indoor housing systems can in themselves pose a threat to animal (and human) welfare. Further, there are some examples where improvements in animal welfare can at the same time lead to environmental improvements. Feedlots for beef cattle are often the cause of considerable air pollution, mainly through the dust clouds that are raised as a result of the activity of the large number of animals involved (43). These dust clouds also contain considerable quantities of micro-organisms (43). In hotter climates, beef cattle in feedlots can suffer greatly from heat stress, which can be a cause of substantial mortality. Providing sufficient shade to cattle can greatly reduce the risk of heat stress, and thus improve animal welfare, but also substantially reduces the animals' level of activity, which may simultaneously reduce the dust clouds (22).

Methods of controlling animal welfare

The previous discussion shows that regulations or standards to improve animal welfare can either conflict with or complement those dealing with food safety and environmental issues. The challenge is to identify the circumstances that favour complementarity over conflict. The authors suggest that many of the supposed conflicts between regulations for animal welfare and those for food safety and environmental issues come from the over-reliance on inflexible design criteria used in many animal welfare standards.

The criteria for assessing animal welfare are conventionally divided into design criteria (also called input or engineering criteria) and animal-based criteria (also called performance or output criteria). Design criteria generally describe the environment of the animals or the way that the animals are kept, and include such aspects as the use of battery cages, space allowances, group size and use of

tethering. Animal-based criteria attempt to directly assess the state of the animals themselves, and include behavioural, physiological and immune measures, incidence of health problems and production levels.

Design criteria are easier to audit and are therefore usually favoured in animal welfare standards or quality assurance schemes (20). Another theoretical advantage is that well-chosen design criteria should prevent welfare problems occurring. Unfortunately, too little is known about the link between design criteria and animal welfare to achieve this in reality. Welfare assessments based on animal-based measures often show wide variation between farms that use very similar housing systems (27) and (as this variation shows) animal welfare standards that rely strongly on design criteria do not inevitably lead to an improvement in the actual state of animal welfare (20, 42). Similarly, standards for organic agriculture that rely essentially on design criteria do not necessarily lead to improved animal health or welfare despite this being one of the avowed aims of the standards (14). Use of animal-based criteria can better demonstrate the actual level of animal welfare, allows for corrective actions to be taken if welfare problems do arise, and can be used to improve housing and management systems.

Design criteria cannot easily establish the equivalence of animal welfare standards in different countries, because different countries may use quite different housing systems or production techniques as well as different breeds of animals. It would be difficult, for example, to establish animal welfare standards for dairy cattle based solely on design criteria that would apply equally to the pasture-based system in New Zealand, the large-scale indoor housing systems in North America, or the smaller-scale mixed indoor/pasture systems in some European countries. In addition, design criteria are created to mitigate currently accepted threats to animal welfare arising from intensive housing/management systems; they have very limited value in dealing with new challenges to animal welfare, such as those associated with genetic modification (5). In theory, animal-based measures are preferable, since it should be possible to measure the actual condition of the animals, irrespective of how they are housed or managed or what the particular threat to their welfare may be.

Design criteria also suffer from a certain degree of inflexibility, and this is at the root of the conflict with food safety or environmental regulations. The impact of any housing system on animal welfare is not fixed but varies greatly with the type of management used (27). However, the quality of management and stock handling can be subtle and is often difficult to specify in design criteria.

Much the same arguments can be made for the effect of housing on food safety and the environment. Rather than a categorical statement that any given housing system has an unacceptable impact on animal welfare, the environment or food safety, assessments should be based on a quantitative assessment of the likely problems so that risks to food safety, the environment and animal welfare can be balanced. In addition, management techniques must be developed that can reduce these risks. For example, use of deep litter for pigs is often judged important to ensure their welfare, but organic bedding can be a source of bacterial contamination and air pollution. However, these negative effects can be offset either by changing litter or by adding fresh layers on the surface of existing litter (3). Direct measurement and control of the cleanliness of the environment and of the animals may be a more effective way of dealing with animal hygiene and air pollution than specifying the quantity or type of litter that is allowed.

Animal welfare criteria that involve animal-based measures allow greater flexibility in designing the housing and management of the animals. In this way, controls to ensure food safety and environmental regulations can more easily be incorporated, while the effects on animal welfare are monitored. A greater use of animal-based criteria can thus reduce conflict between animal welfare regulations and environmental and food safety issues.

Animal health as an indicator of animal welfare

A greater complementarity of animal welfare and food safety comes when suitable emphasis is given to animal health problems as a source of welfare problems. While the authors wholeheartedly agree with Duncan (8) that good animal welfare requires more than keeping animals in good health, it is increasingly clear that many endemic health problems are among the most serious welfare problems, especially for high-producing animals. The incidence of these illnesses may be one of the most effective animal-based indicators of animal welfare. Health measures have long been recognised as potentially useful indicators of animal welfare and have figured prominently in assessments of cattle welfare. Despite this, some (30) argue that researchers in animal welfare have generally paid insufficient attention to animal health problems, and have underexploited measures of the incidence of health problems as indicators of animal welfare. This may partly reflect difficulties in obtaining data about the incidence of health problems in the different types of animal production. Information on animal health is most available and most easily obtained for large, expensive animals such as dairy cattle, and estimates of disease incidence have proven useful in attempts to assess dairy cattle welfare on farms (27, 42). Health data is harder to obtain for extensive management or for smaller, less expensive animals such as poultry.

A second limitation is that the impact of any given disease on animal welfare is still difficult to assess. In animal agriculture, the importance of a disease is often judged by its direct economic impact, but a broader view requires a better understanding of how different diseases affect animal welfare (41). Animal health problems are best related to animal welfare to the extent that they are associated with the animal's suffering (41), either in the past, the present or the future. While most people would agree that good welfare is dependent on good health, in order to be able to use measures of the incidence of different diseases to assess overall welfare, a way must be found to estimate the relative impact of these diseases on animal welfare. A challenge for the future is to establish means of assessing the degree of suffering animals experience as a result of various diseases.

Hazard analysis of critical control points approaches to animal welfare

Ensuring complementarity between standards governing food safety and animal welfare might be easier if the two were assessed in the same manner. However, animal welfare is usually regulated in a much more haphazard manner than is food safety. For example, legislation has often focused on the most contentious animal welfare issues and has been limited to dealing with the individual issues that are of highest concern to the public. Thus the focus has been on restrictive housing, such as tethers or battery cages, and painful procedures, such as branding or dehorning. Other serious welfare problems, such as lameness in dairy cows or respiratory diseases in beef cattle, are less visible to the public and are often not addressed. Furthermore the regulations can be inconsistent: legislation in EU countries bans tethers for sows but allows tethering of cows. This discrepancy may have more to do with the relative degree of public exposure of the issues, rather than any real differences between pigs and cattle. In fact, the health of cattle has been found to be lower when they do not have sufficient exercise (27).

Food safety is increasingly being dealt with through approaches based on hazard analysis of critical control points (HACCP) even at the farm level (1). Recently, there have been attempts at developing HACCP-based approaches to animal welfare, where the emphasis is focused upon systematically identifying and controlling the key threats to animal welfare throughout the entire production system (10, 38). Noordhuizen and Frankena (25) discuss some of the advantages of the HACCP approach to controlling animal health problems, and many of their arguments also apply to animal welfare. The HACCP procedure is a highly formalised one involving a science-based hazard analysis, identification of critical control points, establishment of tolerance limits, and monitoring systems and corrective actions (29).

It is doubtful whether enough is yet known about animal welfare to fully implement a HACCP-based procedure. However, sufficient research has now been done on animal welfare to begin the initial aspects of the HACCP procedure: that is the assessment of risks to animal welfare and identification of the critical control points where risks are high and where some control is necessary. These critical control points are likely to vary from farm to farm and country to country due to differences in the production process. Once critical control points have been identified, the subsequent steps involve establishing a measurable parameter that is used to set tolerance limits at these critical points, and the installation of a monitoring system to ensure that these limits are not exceeded, or to implement corrective action when they are exceeded.

Some concrete attempts have been made to develop HACCP-like approaches to animal welfare. For example, Villarroel *et al.* (37) suggest that too little attention has been paid to identifying critical points during the transport of animals, and attempt to identify these by surveying transport and slaughterhouse facilities in Spain. The German Society of Animal Production recently proposed a list of critical control points for the on-farm assessment of housing for swine (38). Within North America, Temple Grandin (10) has outlined some of the critical control points for the welfare of farm animals, and has begun to develop a HACCP-like animal welfare auditing scheme.

Too little is yet known about animal welfare to begin a full-scale HACCP-like procedure for assessing animal welfare, but continued development of this approach would allow a smoother integration of animal welfare standards with food safety and environmental standards than would the current focus on a few attention-getting issues.

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Liens entre le bien-être animal et les questions de sécurité sanitaire des aliments et d'environnement

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Résumé
Les systèmes modernes de production alimentaire suscitent chez les consommateurs trois types d'inquiétudes : la sécurité sanitaire des aliments, la protection de l'environnement et le bien-être animal. Les normes traitant ces trois questions peuvent être contradictoires et il est primordial de trouver des moyens de réduire ces divergences à mesure que les normes internationales régissant le bien-être animal sont développées. Cet objectif peut être atteint si des normes souples en matière de bien-être animal sont axées sur les animaux et visent à évaluer directement l'état des animaux eux-mêmes plutôt qu'à imposer des conditions d'élevage. Le bien-être animal est souvent traité comme une question éthique qu'il est par conséquent difficile d'aborder dans le cadre des accords commerciaux en vigueur. Une meilleure compréhension du lien entre le bien-être des animaux et la santé animale permet d'élucider celui qui existe avec la sécurité sanitaire des aliments. L'amélioration du bien-être animal peut aboutir à la réduction des risques présents au niveau des exploitations pour la sécurité sanitaire des aliments, principalement grâce à la limitation de l'immunosuppression induite par le stress, à la baisse de la fréquence des maladies infectieuses dans les élevages et à la diminution de l'excrétion et la dissémination d'agents pathogènes pour l'homme par des animaux d'élevage, ainsi qu'à la réduction de l'utilisation d'antibiotiques et de l'antibiorésistance. Les problèmes de santé des animaux d'élevage continuent de représenter une grave menace pour le bien-être animal et la mesure de l'incidence des maladies peut servir de mesure du bien-être des animaux. Le développement permanent d'approches du bien-être animal fondées sur l'analyse des risques et la maîtrise des points critiques permettrait une meilleure intégration des normes applicables au bien-être animal et à la sécurité sanitaire des aliments.

Mots-clés
Analyse des risques et maîtrise des points critiques – Bien-être animal – Environnement – Immunosuppression – Santé animale – Sécurité sanitaire des aliments – Stress.

La seguridad sanitaria de los alimentos, la protección del medio ambiente y el bienestar animal

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Resumen
La seguridad sanitaria de los alimentos, la protección del medio ambiente y el bienestar animal son tres aspectos de la producción alimentaria moderna que preocupan a los consumidores. Como en algunos casos las normas que los reglamentan son incompatibles, será preciso encontrar la manera de limitar sus discordancias a la hora de formular normas internacionales sobre el bienestar

animal. Una solución consistiría en elaborar normas para evaluar directamente su estado, flexibles y fundamentadas en la condición real de los animales, en lugar de imponer únicamente las condiciones de cría. Con frecuencia se considera que el bienestar animal es un asunto ético, por lo que resulta difícil abordarlo en el marco de los acuerdos comerciales actuales. Un conocimiento más profundo de la relación existente entre el bienestar y la salud animal permitirá entender con claridad sus consecuencias en la seguridad sanitaria de los alimentos. Las mejoras del bienestar animal pueden reducir los riesgos que amenazan la seguridad alimentaria en las fincas pecuarias porque disminuyen, en particular, la inmunosupresión ocasionada por el estrés, la incidencia de enfermedades infecciosas, los agentes patógenos humanos eliminados por los animales, además de la utilización de antibióticos y la antibiorresistencia consiguiente. Los problemas de salud de los animales de cría siguen representando una seria amenaza a su bienestar; por ello, la incidencia de las enfermedades puede constituir una medida "animal" para evaluarlo. El desarrollo constante de estrategias sobre el bienestar animal basadas en los análisis de riesgos y puntos críticos hará posible la integración paulatina del bienestar animal y las normas relativas a la seguridad alimentaria.

Palabras clave
Análisis de riesgos y puntos críticos de control – Bienestar animal – Estrés – Inmunosupresión – Medio ambiente – Sanidad animal – Seguridad sanitaria de los alimentos.

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