

Review Article

Review on the Effect of Handling, Slaughtering Process and Transport on Welfare of Animals and Meat Quality in Ethiopia

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Abstract: The current review was initiated to encourage the government of Ethiopia, stakeholders, and policymakers about the substantial effects of handling, slaughtering process, and transportation on welfare and meat quality of farm animals of animals. In Ethiopia, until this review was made, there is no comprehensive legislation, rules, or regulations articulated for farm animals' welfare during rearing, transport, and slaughter. Hence, the welfare of animals was not taken into consideration and often constrained by high levels of poverty, cultural perceptions and beliefs, lack of training and knowledge of animal handling, inadequate transport, and slaughter facilities. The most common farm animal transport system was on the foot from a rural area to a nearby market and then by vehicle to the urban area. During transport, farm animals were exposed to several potential stressors like trip distance, design of vehicle, animal standing orientation, loading and unloading facilities, and temperature fluctuations that affect the welfare, quality, and shelf life of meat and meat products. Aversive ways of handling farm animals, including improper use of sticks, pushing, pulling, and beating them on their head and body frequently by handlers and slaughtering them without stunning, were common practices. This aversive way of handling also causes carcass damage such as bruising, hemorrhages, skin blemishes, blood splash, and broken bones. Therefore, from this review, it has been recommended that, in order to improve animal welfare and thereby meat quality that has been affected by improper handling, transport, and slaughter, the government of Ethiopia is strongly encouraged to endorse inclusive animal welfare jurisdictional acts that would protect animal sentience, define animal welfare in line with OIE standards, and prohibit animal brutality. Creating awareness for stakeholders, particularly for handlers about behavioral principles, proper handling of farm animals, basic concept and role of good animal welfare, and its significant impact on the quality of meat is also imperative.

Keywords: Animal Welfare, Ethiopia, Transport, Slaughter Process, Handling

1. Introduction

The livestock population of Ethiopia ranks first in Africa and tenth in the world. Numerically the country had about 60.39 million cattle, 31.30 million sheep, 32.74 million goats, 56.06 million poultry, 2.01 million horses, 8.85 million donkeys, 0.46 million mules, 1.42 million camels and 5.92 million hive bee colonies [1]. Its contribution to agricultural GDP and national GDP was about 49% and 25.3%, respectively, [2].

Meat is the furthestmost appreciated livestock product and for

several people aids as their primary choice source of animal protein, which provides all the essential amino acids and various micronutrients in proper proportion to human beings [3]. The total meat production of Ethiopia in 2017 year was approximately 597,765 tons and its per capita meat consumption is 8 kg, which was the lowest as compared to other developing (25 kg) and developed countries (77kg) [4]. Meat quality can be defined by organoleptic evaluation parameters such as tenderness, juiciness, flavor, palatability, color, neatness [5], pH, water holding capacity, and its proximate composition [6].

Good animal welfare is a prerequisite for high-quality and

sound farm animal production [7] and is an increasing concern around the world, which has resulted in the introduction and enforcement of government regulations and the formation of animal welfare organizations [8].

In developing countries welfare of farm animals is limited [9] and is often hindered by high levels of poverty, cultural perceptions and beliefs, lack of training and knowledge of animal handling, and inadequate transport and slaughter facilities [10]. There is no significant awareness of stake holders, particularly handlers in Ethiopia [8] regarding animal welfare and hygiene in slaughterhouses and there are no explicit rules and regulations on how animal handling in slaughter, should be done [11]. To address the issue of animal welfare, Ethiopia integrated animal welfare issues in the educational system (curriculum) at the university level, specifically in veterinary and animal science fields of study [12].

The situation of animal welfare has still multi-directional problems [13, 8] and lack species-specific regulation for rearing, transport, and slaughter of farm animals, which in turn alters their welfare [14]. As a result, poor animal handling during transport, marketing, loading, and unloading, before and during slaughtering that could result in poor animal welfare and meat quality are commonly practiced in Ethiopia [15, 16, 8]. Increased stocking densities during trekking could also expose animals to injury and stress [17].

Though several studies have been conducted so far, still in Ethiopia, there is no ministry with direct responsibility for animal welfare, nor any committee or government body devoted to keep animal welfare [14]. Therefore, the current review was initiated to encourage the government of Ethiopia, stakeholders, and policymakers about the substantial effects of handling, slaughtering process, and transportation on farm animals' welfare and meat quality.

2. Transport of Farm Animals

Transportation is a very complex event that compromises animal welfare and quality of meat [15]. In Ethiopia, the most common transport system was on foot from rural areas to nearby markets and then by vehicles to urban areas such as Kera and shola market around Addis Ababa [18]. Since almost all animals were transported by walking on rocky and asphalted roads full of gravel to urban areas, they were exposed to the incidence of lameness and injury to the bone and muscle, swelling of the leg, and inflammation [19]. Traffic accidents are also major problems when they were transported by vehicles [19]. During transport, farm animals were subjected to several diverse probable stressors like fluctuation of climate parameters (temperature and relative humidity) that distress their welfare and even result up to death [20].

For instance, during trekking, about 16% of farm animals died, of which (7.1%) case was due to car accidents and 8.9% was due to other reasons animals [19]. Handling procedures, methods of driving, density of stocking, distance of transport, design of vehicle, animal standing orientation, loading and unloading facilities, and transport by walking were also potential stressors [20, 15].

Animals also stressed when they are separated from familiar and mixed with unfamiliar groups [21]. As a result, disparity in the concentration level of relevant parameters (cortisol, glucose, lactate, and creatine kinase) could occur during transport [15]. The length of transport [22], physical exhaustion, and muscle injury during handling and transport are factors that vary the extent of stress during transport [23, 24].

Level of creatine kinase and lactate dehydrogenase enzyme could be higher in blood plasma when farm animals have encountered substantial stress throughout transportation [25, 24]. Increased levels of creatine kinase and lactate dehydrogenase enzymes are not only affected by transportation but also by deprivation of feed and lack of comfort during the journey [26]. Animals also encounter stress factors such as behavioral and physiological changes [27].

Physiological changes include stimulation of the hypothalamic-pituitary-adrenal axis, which in turn raises cortisol concentrations, immune suppression, and heart and respiration rates [17]. Behavior of farm animals might change during transportation when they encounter fluctuations of temperature in a vehicle higher than 20°C because it causes poor animal welfare [28, 29].

For example, Boran cattle travelled longer distances and more numbers of hours (500 km, for 16 hours) to arrive at Addis Ababa. During this time, animals were exposed to further stress as the vehicle detoured to temporary road, which had much more bumps and vibrations and possibly created discomfort by letting the animal spent more energy to maintain their balance on the truck and fluctuation of temperatures (18.90 to 32.5°C [24]. Pre transport handling, sound disturbance, trembling, unfamiliar grouping, crowding, temperature, humidity, restraint, feed and water deprivation, and duration of transit were factors influencing the level of transport stress [30]. Anxiety is also a crucial psychological stressor during handling and transport of farm animals [17].

Previous acquaintances of farm animals to handling, transport as well and their genetic composition governs the extent of anxiety response of the animal [31]. Another study illustrated that when animals were transported on foot in the market fence, as soon as animals entered the market gate, some animals showed behavioral changes such as becoming curious; ear or tail erecting; vocalizing; jumping here and there; refuse to move forward; running away; fighting against their handlers and against each other; urinating repeatedly; and being aggressive [19].



Source: Antonia Grönvall (2013)

Figure 1. Photo during loading of farm animals for transport.

Table 1. Approximate floor space and maximum distances for transporting different classes of animals.

Classes of stock	Floor area/animal (m ²)	One day journey	More than one day	
			First day	Subsequent days
Mature cattle	1.0 - 1.4*	30 km	24 km	22 km
Small calves	0.3	-	-	-
Porker	0.3	-	-	-
Baconer	0.4	-	-	-
sow/boar	0.8	-	-	-
Sheep/goats	0.4	24 km	24 km	16km

*50-60cm vehicle length/head loaded cross-wise source

Source: Heinz, Gunter, and Thinnarat Srisuvan (2001)

Table 2. Distances and heights of rails for different species.

	Distance of Rail	Height of rail
Cattle	20 cm apart	Top rail 1.5 m high
Sheep/goat	15 cm apart	Top rail 0.9 m high
Pigs	15 cm apart	Top rail 0.9 m high

Source: Heinz, Gunter, and Thinnarat Srisuvan (2001)



Source: Fufa Sorri Bulitta, 2012.

Figure 2. Animals transported from Gudar to Finfinnee city market by walking, exposed to traffic accidents, and by vehicles (by tying their heads to the side of vehicles).

3. Handling Farm Animals

Handling can be described as the activity of humans that involves how farm animals interact, move, and touch during transport [32]. Animal handling is a vital subject that affects both animals' emotional states and economics due to fact that abusive handling can, or most likely will, result in lowered production [33]. Furthermore, [32] indicated that handling procedures are not only important for the animal's wellbeing; they can also mean the difference between profit and loss. Previous experiences and genetics are major factors that determine animal behaving during handling [34].

In Ethiopia, handling of animals is usually in conflict with animal welfare because most commonly stakeholders handle animals in an aversive way [19]. This aversive way of handling arises from poor knowledge of animal behavior, and

handling techniques of handlers includes threatening farm animals by use of sticks and cruel influence against facilities or influence with other farm animals [35].

Improper handling arises from poor knowledge of animal behavior and handling techniques of handlers' [9]; therefore, they commonly push, pull, and beat the animals on their head and body frequently [36, 9]. Even when appropriate handling techniques are used, the greatest physiologic indicators of stress are observed during loading and unloading and at the start of transport [37]. The extent of stress sustained during pre- and post-transport handling is greatly reliant on the comparative docility of farm animals being handled [38]. The increased rate of rude management by the stakeholders increased farm animals' expression levels of aggressive, stress-related and resistance behaviors and can therefore express fear [39, 18].



Source: Fufa S. Bulitta, 2012.

Figure 3. Animal loading processes and groups of animals standing inside the fence of the Gudar market, which is full of sharp rocks.

4. Slaughter of Farm Animals

According to The World Organization of Animal Health, OIE, the veterinary service of the exporting country has ultimate responsibility for the certification of slaughtered animals [40]. But this is still a critical problem in Ethiopia. Most commonly, animals were delivered to the lairage, from different markets to the center of Addis Ababa (Kera abattoir) where there was no shelter, which in turn keeps them from sun or heavy rain and where food and water provision depends on the costumer's request without consent of veterinarian [36].

Throughout the slaughter, the animals were observed expressing stress-related behaviors, such as vocalization 2, head swings, and moving forward 2. The environment inside the slaughter hall is stressful for farm animals with high volume and lots of activity by humans and animals [36]. During slaughter, the use of wet and slippery floors due to a constant water and blood flow was challenging and could be observed as a hygiene problem [36].

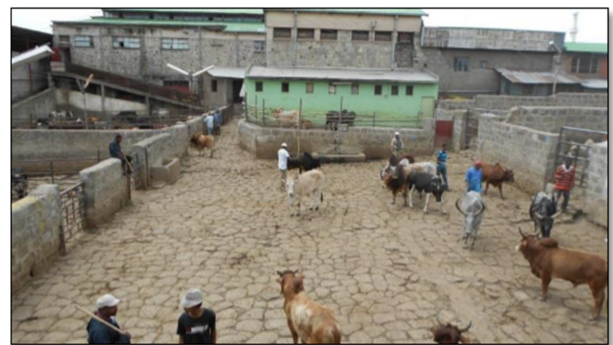
The [41] reported that water in Ethiopia is contaminated with lots of bacteria's and shall not be in contact with the carcass [36, 41]. Use of water during slaughter can also be a health risk in itself, since wet slaughter has been shown to have a higher risk of letting bacteria's grow in the wet environment on the carcass [42]. To avoid this, slaughter should be done in a dry environment, unfavorable for bacteria's growth [41].

Another hygiene and health problem is step in which the carcass is divided into two, by using an axe and cut directly on the bone marrow. As soon as the bone marrow is touched, the risk of spreading possible Bovine Spongiform Encephalopathy (BSE) is very high [41]. As a result of faulty practice during slaughter, large amounts of bruises could be detected in clotted blood collected as darker areas on the carcass in the back areas, around the upper back and on the hind limbs [36].

The duration of slaughter is imperative in many aspects and can be an important factor for meat quality [36]. Providing a very sharp knife and having competent personnel cutting of the carotid arteries are essential during the slaughter process to

avoid pain and suffering [8]. But in Ethiopia, most of the farm animals are slaughtered without stunning, not only because of religious reasons, but also because of continued traditions and lack of further knowledge about modern slaughter techniques [36, 8].

As a result, some animals may take several minutes before they lose brain function and die due to false aneurysms developed in the severed carotid arteries and continuous blood current to the brain [43, 44]. Slaughtering farm animals without stunning can suffer and even cause the aspiration of blood into upper respiratory tract and lungs [45].



Source: Antonia Grönvall (2013)

Figure 4. Photo of the lairage at Kera abattoir, Addis Ababa, Ethiopia seen from above.



Source: Antonia Grönvall (2013)

Figure 5. Photo of the slaughter process in Ethiopia.

Table 3. Recommended current and time features for electrical stunning of different farm animals.

Species	M/Amps	Amps	Volts	Time (sec.)
Pig (bacon/porker)	min. 125	min. 1.25	max. 125	max. 10 (until EPS*)
Sheep/goat	100-125	1.0-1.25	75-125	max. 10 (until EPS*)
Poultry (1.5-2 kg broiler)	200	2.0	50-70	5
Poultry (Turkey)	200	2.0	90	10

Source: Heinz, Gunter, and Thinnarat Srisuvan (2001)

* EPS is electroplectic shock.

5. Welfare of Farm Animals

Animal welfare is a complex and multifaceted issue involving scientific, ethical, economic, cultural, social, religious, and political dimensions [46]. This illustrates how it is interrelated with the well-being of humans and the environment at the diverse levels of society. For instance, protecting and refining animal welfare has both direct and indirect associations with human well-being and environmental issues [47].

Welfare measurement is not always easy and several welfare indicators should be considered in order to draw an accurate conclusion [48]. For proper handling and audit, the American meat institute developed suggested animal handling guidelines and an audit guide for farm animals. Recommended guidelines include core criteria viz: effective Stunning, hot wanding (Pigs only), bleed rail insensibility, falls, vocalizations, electric prod use, and most critical (willful acts of abuse (Egregious Acts) [49]. Animal handling can be explained to a higher extent and a welfare concept implemented when behavioral or physiological conditions are measured [50].

In Ethiopia long years back, attempts have been made to enact proclamations for animal welfare, named as Animal welfare notice No. 187/1947 ET and Endemic animals' welfare regulation No. 191/1947 ET [51]. But still today however, legislation is not implemented and primarily focused only on animal health rather than animal welfare; hence, there is no rule and regulation enacted to keep the welfare of farm animals in Ethiopia [14]. Article 822 in the criminal code proclamation No. 414/2004 states that in the public place, or place open to public or which can be viewed by the public, it is an offense to commits acts of cruelty towards animals or inflict up on them ill treatment, revolting violence, or brutality. It is also an offense to organize or entertainments in which animals treated with cruelty are mutilated or killed (where it is fights between animals or with animals), shooting of captive animals, or other offenses of similar kind. The term 'animal' is not defined in the criminal code, and therefore could extend to all animals including fish and invertebrates [14].

Regarding the presence of animal welfare legislation, there are laws that apply to animals used in farming, including rearing, transport, and slaughter. These include, the basic provisions against the public display of cruelty, which contained in Article 822 of the criminal code for farm animals, Article 515 of the criminal code proclamation No 141/2004 includes further animal health protection regarding the

intentional spread of animal diseases, including domestic animals or poultry, Animal Disease Prevention and Control Proclamation No. 267/2002, which concerned with the prevention and control of animal diseases, movements of animals, animal products and by products, and registration of animal health professionals. But this does not contain any specific welfare consideration [14].

A stated intention of Animal Disease Prevention and Control Proclamation No. 267/2002 is to maximize the benefit derived from livestock resources. Protecting animal health through prohibiting the intentional spread of disease is also the goal of Article 515 of the criminal code. It is acknowledged that preserving animal health contributes to enhancing animal welfare; however, there is no indication for protective measures in the existing legislation explicitly referring to or acknowledging animal welfare. There appears to be a lack of species-specific legislation with regard to the rearing, transport, and slaughter of farm animals (pigs, broiler chickens, egg laying hens, dairy cattle, and calves) [14].

6. Meat Quality

Meat is the furthestmost important source of animal protein for the human diet [52, 53] and has a short shelf life. As a result, it is a perishable and health risk if handled improperly [54]. Improperly handled meat may lead to the growth of foodborne bacterial pathogens, which have been identified as the main encounters to food safety [54].

Meat quality is defined on the basis of their functional or conformational qualities. Functional qualities were referred to as the desirable attributes in a product, while conformance qualities encompass producing a product that meets consumer's specifications exactly [55]. Quality meat became the most critical factor in a highly competitive meat industry in which its profit lies [56]. Color, marbling, pH, tenderness, juiciness, and flavor are technologically important meat quality attributes [57, 58]. Meat quality can also be evaluated by measuring parameters such as pH, water holding capacity, and its proximate composition [6].

7. Effect of Handling, Slaughtering Process, and Transport on Meat Quality and Welfare of Farm Animals

In developing country particularly in Ethiopia, the welfare

of farm animals is often constrained by high levels of poverty, cultural perceptions and beliefs, lack of training and knowledge of animal handling, and inadequate transport and slaughter facilities [10, 8]. For example, handling animals without the practice of using sticks, results in better welfare and less risk of poor carcass quality [58].

Space density allowed for an animal during transport is also one of the most imperative factors influencing its welfare [59]. The issue of animal space during transport is particularly sensitive because costs can be lowered by reducing the space. For these financial reasons, the volume of space above the animal's heads reduced. This reduction may adversely affect adequate ventilation inside the compartment in which the animals are held [50]. Then, their welfare is also adversely affected as a result of violation of recommended animal handling guidelines developed by the American meat institute that states "willful acts of abuse" [49].

Animal welfare was also lowered when they failed to cope with environmental stressors, and, in turn, express chronic stress [18]. This leads to the proclamation that the welfare of farm animals is said to be good when it can handle to accustom with stress factors satisfactorily [60]. When animals are mixed during transport, they show a higher extent of fighting behaviors that can be recorded and measured as a welfare indicator [15]. Another conventional method for this is to use the fact that farm animals that are handled or transported remember previous circumstances where they have been exposed to improper handling by stakeholders because the larger the hesitant animals show, the greater the previous aversion must have been [27].

During slaughter, animal welfare was not considered. For example, a study conducted by [19] on effect the of handling on animals' welfare during transport and marketing indicated that during loading, handlers tied the animal's horn or neck by rope to pull towards the vehicle and beat them repeatedly or bend animals' tails forcefully if the animals refuse to be loaded. The knowledge about animal welfare among the employees at the abattoir was also lacking, and international guidelines from the World Organization for Animal Health [61] were not followed. During the killing, the animals were fully aware and felt pain [45]. Eye reflex could be observed during both the stabbing of the animal's neck and cutting of their head, which results animals feeling pain [36].

The quality and shelf-life of meat and meat products can be affected as result of faulty practices committed during pre-slaughter processes, transportation of animals to the abattoir, and handling of the carcasses [25]. Due to improper handling conditions, meat quality defects like carcass damage (bruising, hemorrhages, skin blemishes, blood splash, and broken bones) are common occurrences found on carcasses [55]. This poor carcass quality is reflected in poorer meat quality [16].

Increased stocking density during transportation was also another factor associated with increased carcass bruising and activity of the muscle enzyme creatine kinase, an indicator of muscle tissue damage [62]. Furthermore, this bruising can result in parts of the carcass being condemned or the meat

being dark [63]. For example, a high number of rejected carcasses was recorded in the country at HELMEX abattoir, Debra Zeit, due to transportation of animals on foot with no or less food/water and in open, overcrowded vehicles. For instance, out of 2688 sheep and goats, 50.1% livers and 42.9% lungs were prohibited from international markets due to parasites and pneumonia [64].

Transport from farm to abattoir, loading of animals at the farm, unloading of animals at the abattoir, and slaughter are critical points that farm animals encounter during pre-slaughter handling [20, 21]. Loading and unloading are the core activities that cause an increase in the heart rate of cattle [20]. Stress before slaughter can have impact not only welfare but also affects end quality of meat [45]. The concentration of glycogen differs significantly during slaughter depending on the part of the muscle, breed type, and nutritional status of the animal, but most of all on the level of pre-slaughter stress [65]. For instance, when animals are exposed to long-term chronic stress, particularly before stunning and slaughter, the level of glycogen in their body decreases, and resulting in biochemical changes in meat [66].

Pre-slaughter stress imposed on farm animals was also increased muscle temperature, lactic acid concentration, and rate of muscle, which in turn results in pale, soft, and exudative (PSE) meat and darker meat [67-69]. For example, dark meat is a quality defect characterized by raised pH as a result of lower levels of glycogen in the blood plasma [67], high water holding capacity, and a dark red, dry, firm, and sticky texture of the lean muscle. Meat quality was affected when farm animals were exposed to poor animal welfare conditions before slaughter [45]. These include, long-term transportation [73], food withdrawal and exhaustion because animals bear pain during long trekking [70, 71], improper handling, duration of restraint, and isolation stress [72, 45].

8. Conclusion and Recommendations

In Ethiopia, until this review was made, there is no inclusive legislation, rules, or regulations articulated for farm animals that consider their welfare, particularly during slaughtering, handling, and transport. This poor animal welfare, in turn affects meat quality. Therefore, improper handling, slaughtering and stressful transporting practice are very common hindrance to meat quality and animal welfare. This includes slaughtering farm animals without stunning where there was no shelter, which in turn exposed animals to stress-related behavior, long trekking on foot under fluctuating environmental temperature, and by vehicles without considering stock density by tying the animal's horn or neck by rope to pull towards the vehicle and beat them repeatedly or bend animals' tails. Improper handling during transport and slaughter arises from poor knowledge of animal behavior and handling techniques of handlers. Trip distances, design of vehicle, animal standing orientation, loading, and unloading facilities were also potential stressors. In general, based on the

above literature reviews, to alleviate substantial distress of handling, slaughtering process, and transportation on the welfare of farm animals and their meat quality, the following recommendations are forwarded.

1. In order to improve animal welfare that has been affected by improper handling, transport, and slaughter, the government of Ethiopia is strongly encouraged to endorse inclusive animal welfare jurisdictional acts that would protect farm animal sentience, define animal welfare in line with OIE standards, and prohibit animal brutality.
2. There shall be also a ministry with direct responsibility for animal welfare that would enact species-specific rules and regulations with regards to the rearing, transport, and slaughter of farm animals.
3. Creating awareness for stakeholders, particularly for handlers about behavioral principles, proper handling of farm animals, basic concept and role of good animal welfare, and its significant influence on the quality of meat is imperative.
4. Good monitoring, appropriate stocking densities, and use of proper transport vehicles that are enriched with transport compartments and lairage pens, particularly in conditions of environmental stress like temperature fluctuation, is by far important to reduce stress during long journeys.
5. The lairage should be designed and constructed based on the OIE standards to enable the farm animals to move freely in the required direction, using their behavioral features and without undue penetration of their flight zone.
6. Continuous measurement and observation during transport in order to devise scientific solutions that in turn could improve the economic benefits derived from animal resources and improve food security and sustainable development.
7. Governmental and non-governmental organizations should reinforce awareness campaigns on improved welfare and thereby meat quality.
8. Sustained audit and management during handling and stunning must be practiced so as to improve the welfare of farm animals and the quality of their meat.
9. Moving animals at a slower pace is preferable because injuries from falls and bruising increase when animals run into gates, walls, and fences.
10. Prior to the journey, feed and water should be provided to the animals and they should be fully rested.
11. If the duration of the journey is such that feeding or watering is required (8 hours or longer, in general), feed and water for all the animals could be carried in the vehicle.

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