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Cafeteria Food Leftover as Potential Livestock Feed Resource in Ethiopia: A Review

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ABSTRACT

There is a growing massive generation of cafeteria food leftover from Ethiopian public higher education institutions, hospitals, hotels, restaurants and other catering providers that could be diverted into economic opportunities. Converting cafeteria food leftover in to livestock feed is an alternative and feasible option to reduce feed cost, enhance livestock productivity and reduce environmental and health impacts. This review aimed to synthesize, discuss and document the available scientific information on cafeteria leftovers with respect to its value as source of animal feed in Ethiopia. The paper attempted to use previous studies, literatures from journals, on the nutrient composition of cafeteria food leftover and its utilization as livestock feed resource. It has been observed from earlier research works that cafeteria food leftover has high caloric value, low crude fiber and moderate crude protein content signifying its potential to be incorporated in the diets of both non-ruminant and ruminant animals. However, most of the research works focused on non-ruminant animals (poultry and pigs); suggesting the need to evaluate the potential supplementary value of cafeteria food leftover for ruminant animals. Strict regulations mechanisms should be introduced by the Ethiopian government for proper utilization of cafeteria food leftover as animal feed and reduce the risks associated with its utilization.

Key words: Cafeteria, Leftover, Livestock, Non-conventional.

Ethiopia has the largest livestock population in Africa with an estimated population of about 59.5 million cattle, 30.7 million sheep, 30.2 million goats and 59.5 million chickens (CSA, 2017). The livestock sector accounts for about 45 per cent to the total value of agricultural production and supporting the livelihoods of a large share of the population (FAO, 2019). The growing domestic and global demand for animal source foods provide significant business opportunities for livestock producers and make the sector an important contributor of the country's economy (FAO, 2019; MoA and ILRI, 2015). However, the supply of livestock products, as in many developing countries, is constrained by low animal productivity, largely due to shortages of quality animal feeds. Currently, the cost of conventional feed resources for intensive livestock production is rising. There is, therefore, a need to look for alternative locally available, nutritious and cheap non-conventional feed resources that could potentially replace the expensive feed ingredients. One of the available options to cope with this problem is making use of food wastes, including cafeteria leftover, as livestock feed (Amene *et al*. 2015). Feeding food wastes to livestock could lessen the amount of conventional feeds like cereal grains needed to support the livestock industry. It can also contribute profoundly by decreasing environmental pollution (Dou *et al*. 2018; Yang *et al*. 2001).

In Ethiopia, there has been massive expansion of public Universities in recent years with associated momentous raise in the country's annual student enrollment rate (Cantrell *et al*. 2010). The annual average student enrolment rate in public and private higher institutions between 2003/04 and 2016/17 has increased by 26.1% (58,632 to 860,378 students) (EMIS, 2016/2017). Significant portion of these students reside and have their meals in the universities' cafeterias' that leads to generation of sizable amount of food leftover (Gashaw *et al*. 2012). A substantial amounts of food leftover is also produced from hospitals, hotels, restaurants and other catering providers (Negasa, 2015). This massive cafeteria food leftover poses severe environmental and health issues (Gebrehiwet *et al*. 2018) that otherwise could be diverted into economic opportunities. For example, universities could create a link with the nearby by farms to help them utilize this invaluable resource to reduce the farms cost of production, enhance livestock productivity and reduce environmental and health problems. Researches have been conducted on the feeding value of cafeteria food leftovers as animal feed. However, the information generated from such research works are not yet systematically compiled and made available to users. The purpose of this review is, therefore, to synthesize, discuss and document the available scientific information on cafeteria leftovers with respect to

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its value as source of animal feed in Ethiopia. The nutritional quality of cafeteria leftover and its replacement value for conventional feed ingredients in the diets of broilers, layers, pigs and ruminants are discussed in this review paper.

Relevant data were collected using appropriate keyword search engines. The sets of keywords include: nutritional value of cafeteria food leftover, cafeteria waste utilization for feed, 'concerns over feeding raw cafeteria leftover as well as several combinations of them.

Cafeteria food leftovers

Inclusion of food leftovers from cafeteria, hotels and restaurants have been a common practice worldwide for centuries (Westendorf and Myer, 2018). There is, however, a renewed interest in using it as animal feed due to not only its nutritional quality and economic feasibility, but also due to its significant environmental and health impacts. Solid waste management, including food leftover, in Ethiopian higher education institutions has become one of the greatest challenges for institutional sustainability (Senbeta, 2020) and imposing serious environmental and health related problems (Gebrehiwet *et al*., 2018). It has also been reported that food waste is the single largest category of municipal solid waste in Ethiopia (Alemayehu and Abile, 2014). It is, therefore, with this massive generation of food wastes and its associated negative impacts that researchers are showing great interest to look options for diverting this resource in to economic opportunities including converting into biogas (Alemayehu *et al*. 2014; Alemayehu and Abile 2014; Gebrehiwet *et al*. 2018) and as animal feed (Amene *et al*. 2015; Negasa, 2015). Sizable quantities of cafeteria leftover are being generated from different Universities' students' cafeterias (Alemayehu *et al*. 2014). Helelo *et al*. (2019) determined weekly solid waste produced from all campuses of Hawassa University of Ethiopia. It was found that about 18.5 tonnes of food leftover was produced per week, which accounts about 77% of the total solid waste of the University. Gebreeyessus *et al*. (2019) also reported that major components of the waste at Kotebe Metropolitan University of the university Ethiopia were food waste (84.4%).The weekly food waste generation was about 1.2 kg per student (using cafeteria) in all campuses of Hawassa university of Ethiopia (Helelo *et al*., 2019). Food leftovers are also widely available from private restaurants, hotels and cafeterias (Amene *et al*. 2015). The major food ingredients, among others, are Ethiopian pancake "Enjera" which is made up of a cereal grain Teff, wheat bread, pasta, rice, beef and mutton meat and various vegetable types along with different kinds of stews/sauce are among the major ingredients (Amene *et al*. 2015; Alemayehu *et al*. 2014). Converting food waste into livestock feed is believed to be a game changer, simultaneously addressing multiple challenges such as waste management, food security, resource conservation, pollution and climate-change mitigation (Dou *et al*. 2018).

Nutritional aspects of cafeteria food leftover

Protein content

Dried cafeteria food leftover from public higher institutions has shown wide variations (9-17.6 %) in crude protein (CP) content (Alemayehu and Abile, 2014; Amene *et al*. 2015; Asmamaw and Dinberu, 2015; Negasa, 2015) (Table 1). The CP value of cafeteria food leftovers reported by different researchers is lower than the values (20-28%) reported by Westendorf *et al*. (2000) and Myer *et al*. (1999). The difference in crude protein composition between different research works might be attributed to differences in food type, methods of food preparation, moisture contents and processing methods (Mosebework *et al*. 2018). The reported CP content of dried cafeteria leftover is below the recommended level for layers (16-17%) and grower broilers (20%) (NRC, 1994). The low CP content for dried cafeteria leftover can be corrected through inclusion of other locally available and cheap protein sources. The value of CP (17.5%) in cafeteria leftover documented by Asmamaw and Dinberu (2015) is within the range (17-20%) required by growing pigs (NRC, 1998). The range of CP for cafeteria leftover is higher than maize grain (8.5%) (Mosebework *et al*. 2018), which is the most commonly used conventional feed ingredient in poultry ration. Cafeteria leftover has also comparable CP content with finger millet (9%) (Yilkal *et al*. 2018). Unlike ruminant animals, formulating poultry rations based on crude protein values is not the recommended way as it does not show the individual amino acid profile of feed ingredients. In this view, the amino acid profile of cafeteria leftover is not yet determined in Ethiopia, which requires further research works for its effective utilization in poultry ration. The CP content of dried cafeteria leftover is also above the minimum level of CP (7–8%) required for optimum rumen function (Van Soest, 1994). It is also above the recommended minimum requirements for lactation (12%) and growth (11.3%) in ruminants (ARC, 1984), which can justify its inclusion in the diet of lactating and growing ruminants.

Energy value

The reported metabolizable energy (kcal/kg) value of dried cafeteria leftover (3808- 4029 kcal/kg DM) (Amene *et al*. 2015; Asmamaw and Dinberu, 2015; Negasa, 2015) (Table 1) is well above the optimum level required for growing broilers (3200 kcal/kg DM) and layers (2800-2900 kcal/kg DM) (NRC, 1994) implying its potential to be used as energy source in both broiler and layers rations. It has also higher ME value compared with finger millet (3280 kcal ME/kg DM) (Yilkal *et al*., 2018) and maize (3678 kcal ME/kg DM) (Mosebework *et al*. 2018). This indicate the potentials of cafeteria leftover to fully or partially replace the commonly used energy sources like maize in both broilers and layers rations depending on availability. The high ME value of cafeteria food leftover might be due high calorie wastes like bread, oil, pasta and rice (Alemayehu and Abile, 2014).

Mineral, crude fiber and ether extract content

The reported value of Ca (0.8-2.0%) in dried cafeteria leftover (Amene *et al.* 2015; Asmamaw and Dinberu, 2015; Negasa, 2015) (Table 1) is below the recommended level (3.52-3.62%) required for maximum egg production (William *et al*. 2006). The Ca content of dried cafeteria leftover is higher than the reported values for maize (0.03%) and finger millet (0.42%) (Yilkal *et al*. 2018). Hence, this deficiency could be corrected thorough inclusion of other feed ingredients that are rich in calcium if cafeteria leftover is to be included in layers ration. According to Amene *et al*. (2015), dried cafeteria leftover had 0.7% P which is comparable to the requirement for layers (NRC, 1994). The reported Ca and P values of cafeteria food leftover in Ethiopia are comparable with the values of dehydrated restaurant food waste products (Myer *et al*. 1999). The crude fat and crude fiber content in dried cafeteria leftover have been reported in the range of 2.4-13.1 and 1.3- 3.6%, respectively (Amene *et al*. 2015; Asmamaw and Dinberu, 2015; Negasa, 2015). Amene *et al*. (2015) documented higher level of ether extract (13%) in dried cafeteria leftover compared with Noug seed cake (8.1%), Soya bean meal(9.2%), which might be due to the presence of edible oil.

Nutrient digestibility

The digestibility of nutrients in food wasted is generally not poor .Increasing trend in dry matter and nutrients digestibility has been described as the proportion of cafeteria left over increased in the diet pigs feed concentrate based on maize and other diets (Amene *et al*. 2015). This might be due to low level of crude fiber content of cafeteria leftover than other treatment diets. Conversely, Rivas *et al*. (1994), reported a decreased in crude protein digestibility as the proportion of restaurant waste increased in the diet. This discrepancy could arise from the difference in the nature of food wastes (Amene *et al*. 2015). Myer *et al*. (1999) reported moderately higher protein digestibility and available lysine in dried food waste compared to soybean meal, which is known to be excellent for these nutrients.

Effects on animal performance

The dry matter intake of layers increases as the level of inclusion in the conventional layer ration increases up to 60 per cent (Negasa, 2015). In another experiment, however, lower nutrient intake observed when the proportion of cafeteria food leftover in the diets of Ross broiler chickens increased (Asmamaw and Dinberu, 2015).

The percentage of hen- day egg production increases as the inclusion level of dried cafeteria food leftover increases in the diets of White Leghorn Chickens. In addition, hen housed egg production, egg weight, egg mass and feed conversion ratio did not vary significantly when dried cafeteria leftover was used to replace 60% of the conventional corn based layer ration (Negasa, 2015). Kuo-Lung *et al*. (2007) also reported an increased feed intake and feed conversion ratio with increasing level of dehydrated food west product on mash-based diets. Body weight gain, average daily gain and nutrient efficiency ratio and major carcass cuts weight of Ross broiler chickens fed on sole dried cafeteria food leftover were lower compared to sole formulated pelletized ration and when up to 67% of formulated pelletized ration was replaced by dried cafeteria leftover (Asmamaw and Dinberu, 2015). According to the same source, however, comparable average weight gain, average daily gain and feed conversion ratio were obtained when 33% of the formulated pelletized broiler ration was replaced by dried cafeteria leftover. The observed positive effect of pelleting on broiler performance compared to sole dried cafeteria food leftover, which was presented in mesh form, might be partly due to improved nutrients digestibility, increased feed consumption (Zalenka, 2003; Meinerz *et al*. 2001).

In pigs, the highest body weight gain and feed conversion ratio were obtained when 67 % of the concentrate mixture in the ration for growing castrated male pigs is replaced with dried cafeteria (Amene *et al*. 2015). Similarly, Westendorf *et al*. (1998) found that growing or finishing pigs fed food waste performed nearly as good as pigs fed a traditional diet when the food waste was supplemented with corn. It has been reported that an increased feed intake on pigs fed with increased level of dehydrated food wastes associated with higher amount of crude fiber (Chae *et al*. 2000).

Concerns over feeding of raw cafeteria waste

In Ethiopia, there is a growing practice of using cafeteria food leftover in the diets of animals in and around towns where these resources are abundant. Presently, due to the high cost of commercial rations, there is also a practice of feeding different food leftovers collected from different commercial restaurants' and cafeterias' without applying any treatment. Westendorf and Myer (2018) indicated that food

Table 1: Chemical composition of cafeteria/food leftover used in different experiments with farm animals.

Sample type	On DM bases, %								Reference
	DM	CP	EE	CF	Ash	Ca	P	ME (kcal/kg)	
DCFL	91.2	9.0	13.0	3.6	7.6	0.8	0.71	4028.8	Amene *et al.* (2015)
DCFL	92.2	11.8	7.6	ND	3.0	ND	ND	ND	Tregay (2019)
FCFL	94.0	11.7	8.7	0.58	4.9	ND	ND	4170.7	Lamesgin *et al.* (2020)
DCFL	91.2	9.0	13.1	3.6	7.7	0.8	0.7	4029.5	Negasa (2015)
DCFL	90.4	17.6	2.4	1.3	3.8	2.0	ND	3807.5	Asmamaw and Dinberu (2015)

Ca= Calcium; CF= Crude fiber; CP= Crude protein; DM= Dry mater; DCFL= Dried cafeteria food leftover; EE= Ether extract; FCFL= Fermented cafeteria food leftover; kcal= Kilocalorie; kg= Kilogram; ME= Metabolizable energy, ND= Not determined; P= Phosphorus.

waste, including cafeteria food leftover, to be included in the diets of animals must be properly treated using different mechanisms to reduce the risk of disease transmission and eliminate any other harmful pathogens. Food leftover is also being used by poor people, which is a challenge due to poor hygienic quality and health implication. Food leftover should be properly dried before use to ensure the feed quality and animal's health (Senbeta, 2020). The Ethiopian government should also apply relevant laws and regulations to ensure proper utilization of cafeteria food leftover as animal feed. Proper training should also be given regarding the safe and scientific ways of including cafeteria food leftover in the diets of animals.

CONCLUSION

Cafeteria food leftover has high caloric value, low crude fiber and moderate crude protein content. The nutritional aspects of cafeteria food leftover signify its potential to be included not only in the in the diets of non-ruminant animals but also in ruminant animals' diet. However, available research works on the feeding value of dried cafeteria food leftover have been limited to non-ruminant animals (poultry and pigs). Hence, further research work on the potential supplementary value of cafeteria food leftover for ruminant animals is warranted. Strict regulations mechanisms should be introduced by the government for proper utilization of cafeteria food leftover as animal feed and reduce the risks associated with its utilization.

Conflict of interest: None.

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