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AGRICULTURAL RESIDUES AND THEIR UTILIZATION AS ALTERNATIVE FEED RESOURCES IN EGYPT: A REVIEW ARTICLE

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SUMMARY

The last 60 years have seen an increase in the world's meat consumption. The FAO reports that since the 1960s, the world's meat production has expanded fivefold. According to FAO, 2023estimates, 364 million tons of meat will be produced. Meat output needs to rise to 498 million tons by 2050 to keep up with the growing global population. Conversely, the FAO recommended that a daily minimum of 29.3g of animal protein per capita be consumed. Regretfully, 19.2 grams of animal protein are consumed per day/person in Egypt. One of the most important elements limiting the growth and profitability of animal production is the feeding redients. Feed ingredients are one of the most critical factors that limit the development and profitability of animal production. Over 80% of the expenses associated with producing animals are related to feed. Nonetheless, agricultural techniques in Egypt generate 27.683 million tons of agricultural leftovers, which have low nutritional content. Thus, there are numerous ways to make use of such massive agricultural wastes sustainably. These wastes can provide numerous high-energy and useful products, such as compost production (bio-fertilizers), food production (growing mushrooms), energy production (Biogas, biodiesel, and bioethanol), multitudes of bio-chemicals and animal feed production. This review tries to throw some light on the different methods of utilizing agricultural wastes as alternative feed resources in the desert and marginal environmental conditions of Egypt.

Keywords: Agricultural wastes, animal production, feed ingredients, processing

INTRODUCTION

The number of sheep in Egypt is about (1.9 million head) and goats (1.1 million head) (EAS, 2022). The estimated sheep population is about 2.972 million head, and the great majority of the total sheep population is indigenous breeds (Abd-Allah, 2024). However, the availability of conventional feed resources is declining as livestock populations increase (FAO, 2018). There was a shortfall in dry matter (14.42 million tons) and total digestible nutrients (-2.21 million tons), but surplus of digestible crude protein (+1.11 million tons) in the ruminant feeding balance in 2012 (Kewan and Khattab, 2016). In Egypt, there is a serious gap between available and required amounts of animal feeds and it was calculated to be 4.2 million tons of total digestible nutrients (TDN) per year (Shoukry, 2019). This led the specialists in animal nutrition to search for alternative feedstuffs or agro-industrial by-products that may replace corn grains as a source of energy in animal rations. To overcome this shortage, agriculture by-products have received research attention in recent times as alternative feed. These materials that do not compete with human food, can provide significant amount of feed which lead to cover a great part of the deficit particularly in the dry season (Makkar and Ankers, 2014) especially under desert conditions. The unconventional feed resources in Egypt are characterized by their low crude protein content and dry matter digestibility, but high ash, and crude fiber contents. The total value of plant residues is estimated at 15.8 billion EGP, while, the quantity of this reached 25 million tons in 2019 representing about 3% of the value of agricultural income, and about 5.5% of the value of plant output in 2019 (Hamza *et al.*, 2021). Unfortunately, this quantity increased to reach 29.645 million tons during the year 2021 according to Khedra *et al*. (2023), and this is an indication of the lack of optimal use and handling of agricultural waste.

Residues (straw, stake, trimming waste of fruit trees, etc.) must be utilized at least as feed resources in animal nutrition and to mitigate environmental pollution as well. Agricultural by-products are produced during agricultural production, processing and distribution, among other stages of the food supply chain. These wastes can provide numerous high-energy and useful products, such as compost production (bio-fertilizers), food production (growing mushrooms), energy production (Biogas, biodiesel, and bioethanol), multitudes of bio-chemicals and animal feed production. Some attempts such as biologically treatment, total mixed ratio technique (TMR), silage, of agricultural wastes could cover the maintenance requirement of nutrients for sheep under the desert conditions besides reducing feed cost and preventing environmental pollution (Abo Bakr *et al*., 2020 a or b). Therefore, this paper aimed to talk about some attempts which can be perform for enhancement and utilization of agricultural wastes to become more useful, economically beneficial, higher environmental safety and providing job opportunities and achieving higher financial returns for workers in the agricultural field.

Agricultural residues as a suggested solution to develop animal productivity in the Egyptian desert

Definition of Agricultural residues:

Plant material left over after harvesting, such as leaves, stalks, and straws, is referred to as agricultural residue. Accordingly, the result of agricultural products after various harvesting operations is referred to as agricultural trash (Abou Hussein and Sawan, 2010). Agro-industrial by-products are also created during agricultural production, processing (olive oil, dates, orange juice, etc.), and distribution, among other stages of the food supply chain. They include mostly fruit and other vegetable seeds, peels, stems, and leaves, as well as useless pulp. Food waste is also created concurrently, and waste food can be distinguished from a particular by-product, such as fruit pulp that is thrown out of a finished product but is still fit for human consumption. According to Jiménez-Moreno *et al*. (2020), up to 42% of it was produced in the home, 39% in the food manufacturing industry, 14% in the food service sector (restaurants and ready-to-eat food), and 5% during delivery. Comparing with agricultural residues, the majority of agro-industrial by-products are less fibrous, more concentrated, more nutritious, and less expensive (Aguilera, 1989and Sun *et al*., 2024).

Constraints to using agricultural residues:

The low dry matter digestibility and crude protein content of the agricultural residues accompanied by high ash and crude fiber concentrations are the most the restriction points (Kewan *et al*.,2021).This property leds to low nutrients digestibility and nutritive value, straw's main cell walls are made of lignin, cellulose, and hemicelluloses. Residues also have a low mineral content particularly phosphorus and vitamin deficiencies. Sometimes animals face problems when we offer agricultural residues as feed. For example, feeding crop leftovers and some leguminous plant leaves can lead to metabolic problems (Soetan and Oyewole, 2009; Njidda, 2010and Wadhwa and Bakshi, 2013). On the other hand, most of the residues possess some secondary metabolites. Also, some crops have mineral deficiencies (Wadhwa *et al*., 2006). However, several obstacles still prevent agricultural residues from being used to their full potential. These obstacles include poor storage conditions, high transportation costs, lack of knowledge about the nutritional value and possible uses of agricultural residues, lack of agriculture extension services, lack of cutting-edge technology, and lack of farmer-level trials (Lukuyu *et al*., 2011and Devendra and Leng, 2011).

Categories of Agricultural residues:

Agricultural crop residues:

Egypt has three distinct seasons for crop cultivation. Winter crops are the first category of crops consists of grains like wheat and barley, legumes like beans and lentils, fibers like flax, fodders like clover and green fodder, medicinal and fragrant plants and vegetables. Summer crops, which include grains like rice, maize and sorghum; oily crops like soybean, peanut, sesame and sunflower; sugar crops like sugar cane; fodders like alfalfa and green fodder; fiber crops like cotton and kenaf; aromatic and medicinal plants and vegetables, make up the second category of crops. The third category of crops is known as Nili crops, and it is grown from July through August until the start of winter and they are similar to those planted in the summer and include rice, maize, sorghum, and oily crops and feeds. The majority of Egypt's agricultural output comes from both summer and winter crop production (Abou Hussein and Sawan,2010). Table 1. Shows the total area of crops and waste generated in the regions of the Egypt according to Egypt Economic Affairs Sector (2019) of the Ministry Agriculture and Reclamaztion.

Table 1. Total area of crops and waste generated in the regions of Egypt

Region	Crop area (million acres)	Amount of agricultural waste (million tons)	Waste production percentage (%)
Lower Egypt Governorates	8.601	21.55	58.42
Central Egypt Governorates	2.718	6.13	16.61
Upper Egypt	2.132	4.74	12.85
Governorates outside the valley	2.176	4.47	12.12
Total	15.627	36.89	100.00

Vegetable by-products:

The definition of vegetable by-products (thrones of tomatoes, strawberries, peas, beans, cantaloupes, etc.) are any products that result from different vegetable processing stages that are acceptable for human health and safety as well as ideal for animal feeding (Kasapidou, *et al*., 2015). Numerous waste products are generated by vegetable cultivation at various points during the food production process, leading to severe ecological hazards. The use of vegetable by-products in animal nutrition has some benefits they are put into practice properly, including the potential of lowering the food production chain's environmental impact, lowering the cost of feeding animals, and enhancing the sustainability and quality of animal products (Jalal *et al*., 2023). Additionally, Table 2 demonstrats that highly fermentable sugars typically make up a large portion of the chemical compositions of vegetable by-products (Palmonari, *et al*., 2021). They found that the digestion coefficients of DM, OM, CP, EE, CF and NFE% were not affected by additives of trace minerals (Ash).

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Table 2. Comparison between the chemical composition (%) of Berseem hay and some of vegetable by-products

Items	Berseem Hay*	Watermelon vines hay*	Berseem Hay**	Strawberry vines**
DM	88.12	87.86	87.17	84.84
OM	92.67	91.45	88.05	88.42
CP	12.76	8.63	13.24	8.98
CF	24.81	28.62	30.19	17.86
EE	1.62	1.36	1.71	2.31
NFE	53.48	52.84	42.91	59.27
Ash	7.33	8.55	11,95	11.58

*Fayed *et al.,* 2019 and **Galal et al., 2016

Trimming Waste of Fruit Trees:

Egypt is characterized by the cultivation of some types of fruits, especially the production of citrus (Bampidis and Robinson, 2006) and palm trees. One of the most popular tree fruits is the citrus fruit, which is commercially grown around the world in tropical and subtropical climates (Khan *et al*., 2020 and Hayat *et al.*, 2022). Citrus fruits, such as oranges, mandarins, lemons, limes, pummelos, grapefruits and several others, are members of the Rutaceae family, which has 1300 different species and 140 different genera (Morton, 1987and Shireen *et al*., 2018). Due to agricultural farm operations, a large amounts of citrus trimming by-products (Table 3), nearly 3.1 million tons, are produced annually (AOAD, 2006) that are put to beneficial usage and disposed of as waste.

Table 3. Some of chemical composition of some trimming wastes (DM Basis)

Author	DM	OM	CP	CF	Ash	Reference
Olive trees by-products	93.95	86.50	6.48	24.66	13.50	Mahrous *et al*. (2019)
Trimming waste of mandarin trees	93.65	86.61	14.37	27.00	13.39	Abo Bakr, *et al*. (2020 a or b)
Date palm leaves	93.41	90.59	5.98	41.97	9.41	Aziz (2020a)
Moringatree stalks	92.53	92.17	6.48	37.81	7.83	Kewan *et al*. (2019)
Pruning peach trees by-products	92.50	93.40	9.50	24.30	6.60	Khir, *et al*. (2015).
Pruning grape trees by-products	92.72	93.91	5.40	42.90	6.09	Phillip *et al*. (2014)

Utilizing fruit tree residues has several benefits, including reducing feed costs and thereby raising the economic efficiency of livestock production, as well as addressing environmental pollution and the health risks that arise from burning these residues (Khir *et al*., 2015 and Borhami and Yacout, 2001).

By-products of the Agroindustry:

Agro-industrial by-products are resulting from the processing of primary products (Alnaimy *et al*.,2017). Agro-industrial by-products represent about 30% of global agricultural productivity. It involves by-products of different crops and the food industry. This waste includes fruit (depending on the fruit cultivar and technology used), citrus peel waste (CPW), which is generated after processing, can range from roughly 50% to 70% of processed fruits. Its yearly global production is likely nearing 10 million tons (Zema *et al*., 2018) and vegetable pulp such as discarded dates that are not suitable for human consumption (damaged, poor quality or old, Hassan, 2004). In Egypt, there are some common agro-industrial by-products in desert areas of Egypt that can be used as feedstuff ingredients and cover energy requirements for livestock herds. These products include the following by-products:

Date palm:

Dates are considered among the most significant fruit crops in areas that are tropical or subtropical such as Egypt; In 2020, Egypt produced 1,711 million tons of fresh dates. As a result of agricultural industrial processes, numerous studies have shown that a variety of by-products, including low-quality dates and date pits, can be fed in significant amounts to cattle as well as used in vegetable diets. Discarded dates are a good substitute for regular cereals in animal diets because of their high-calorific content, total digestible nutrient (TDN) and palatability for animals (livestock). So, it can serve as an effective substitute for regular cereals in diets of animals (Al-Dobaid *et al*., 2009 and Almitairy *et al*., 2011), they also stated that it could be used as a source of energy to replace part of the corn grain (Khattab *et al*., 2014).

Table 4. Comparison between chemical compositions (%) of corn grain (CG) and discarded dates

Items	Corn grain	Discarded dates
Organic matter	98.42	95.69
Crude protein	8.53	7.42
Crude fiber	2.54	7.52
Ether extract	4.16	3.83
Nitrogen free extract	83.19	76.92
Ash	1.58	4.31
Total sugars	8.28	46.95

Cited from Khattab *et al*., 2014

Date seed:

As a result of the availability in abundance throughout the year, date seeds as an agro-industrial by-product is commonly used in the formulation of ruminant ration (Abdou, 2003 and Al-Farsi and Lee, 2011). Table 5 shows the chemical composition of date seed according to different references. The packing of dates comes after an industrial process that yields enormous quantities of seeds as by-products. Other names for date seeds are pits, pip, stones, and kernels. The fruit's seed makes up between 10 to 30% of its weight. For this reason, a lot more date seeds are frequently employed as a feed energy source in dry regions. It costs little and can be given to animals in ground or crushed form.

Table 5. Chemical composition (%) of date seeds

Author	DM	OM	CP	CF	EE	NFE	Ash
Khattab, 2000	91.7	92.89	7.92	19.55	5.65	59.77	7.11
Youssef *et al.* 2001	-	90.18	9.60	15.47	2.97	62.14	9.82
Nassar, 2002	-	97.99	10.5	8.60	9.43	69.46	2.01
Kewan, 2003	90.2	98.06	7.12	20.63	8.43	61.88	1.94
Aziz, 2004	92.8	98.60	6.90	9.70	6.40	75.60	1.40
Awad, 2006	92.1	92.40	7.00	26.30	3.90	55.20	7.60
Abo Bakr,2006	90.1	98.27	8.80	12.30	6.00	71.17	1.73

Olive cake:

An important crop in Mediterranean nations is olive (Berbel and Posadillo,2018). Currently, the olive is one of the most cultivated fruit species. The olive (*Olea europaea* L.) is a member of the Oleaceae family, which is in the genus Olea. Around 10.6 million hectares were planted for this crop in 2019, and 19.5 million tons of olives were harvested in total (FAO, 2021). The total cultivated area of olives in Egypt in year 2020 is about 208.6 thousand acres, producing around 736.7 thousand tons (El Sayed and Mohamed,2021).

Olive oil extraction contributes to the production of many different by-products, the primary among of them being olive cakewhich represented 0.55-0.80 from fruits (Habeeb *et al*.,2017). According to Berbel and Posadillo (2018), olive cake can be harmful to the environment and it is difficult to dispose of. Table 6 shows that the nutritional value of olive cake can help ruminants meet their maintenance needs. Olive pulp, skin, stone, and water make up an olive cake (Molina-Alcaide and Yáñez-Ruiz, 2008).

Table 6. Chemical composition of olive cake (DM basis)

Author	DM	OM	CP	CF	EE	NFE	Ash
Farahat (2022)	95.05	93.69	6.10	34.44	10.00	43.15	6.31
Abd El-Hay (2020)	73.85	96.20	7.79	28.64	12.34	47.43	3.80
Ashmawy (2011).	86.31	96.00	8.52	30.08	10.68	46.72	4.00
Abo Bakr (2006)	91.50	93.80	8.30	34.20	7.00	44.30	6.20
Aziz, (2004)	92.50	93.40	9.50	24.30	7.30	52.30	6.60

The primary obstacles of feeding animals on agro-industrial by-products:

The primary limitations may result from the limited time of use, which includes seasonal availability and regional production. Furthermore, because some feed sources have high moisture content and would cost more to handle and transport, many farmers are unaware of their nutritional benefits. The growth of mold (aflatoxins) can be hazardous and almost with the presence of the anti-nutritional factors (Alnaimy *et al*., 2017). Although, Ahmed, *et al*., (2001) reported that it can be added as an energetic feed source, due to that itconsists of important biomass and can be used as a solution of animal feed shortage, if suitable technologies could be applied practice.

Advantages of usage of Agricultural residues:

The following are some benefits of using crop residues:

- Ruminants are valuable because they can transform inferior feed into superior products. This happens due to the symbiotic relationship between ruminant animals and rumen microflora. In addition to providing fodder in areas where it is scarce.

- Decrease in environmental contamination and ensuing health risks due to the incineration of these leftovers (Khir, *et al*., 2015).
- Decreasing feed costs leading to an increase in livestock production's economic efficiency (Borhami and Yacout, 2001 and El Ferink *et al*., 2008). Also, usage as an alternative feed ingredient especially with the high price of concentrate feed ingredients in developed countries.

Some approaches to enhance nutritive value of agricultural residues:

There are many attempts for solving the nutritional restriction aspects (low protein contents and highly contents of crud fiber especially lignocellulosic compound) found in agricultural by-products and agro-industrial by-products as follow: -

1) Physical/mechanical treatments:

Natural treatments:

As a result of industrial processing, some waste is produced and can be used in natural treatment for non-conventicle roughage, for example of this material:

Molasses:

It is the main byproduct of the sugar industry, which is produced in many temperate and tropical Regions, which involves sugarcane and sugar beet. Condensed from fermentable carbohydrates, molasses has high energy content along with a broad spectrum of vitamins and trace elements. Apart from its nutritional function, this is by-product is regarded to its stickiness and taste to the block. Free molasses feed blocks are available in many regions where molasses production is not practiced.

Condensed molasses soluble (CMS):

Condensed molasses soluble (CMS) is a waste product from the distillery industry that is obtained during the ethanol production process from molasses and comprises both organic and inorganic components. It is commonly referred to as vinasse (Lopez-Campos *et al*., 2011). Vinasse is the liquid fraction that remains after ethanol is rectified and distilled. CMShas some properties such as its utilizationwhich is a source of non protein nitrogen (NPN) in ruminant feeding; it has very good mineralconcentrations. However,results of priverous studies had shown that CMS level ofsulfur and potassiumhas a low dry matter content, a high sulfur level and potassium (Stemme *et al*., 2005). The CMS has a low CF and EE content (Lopez-Campos*et al*.,2011). The CMS is made up of NPN, which mostly consists of minor amino acids like glutamic and aspartic acid, as well as ammonia and betaine (Iranmehr *et al*., 2011 and Zali *et al*.,2017). Ma *et al.* (2021), using different level of CMS which ranged between 1 to 4%, who recommended that the optimal level of it was 3%.

2) Chemical treatment:

According to Ben Salem and Smith (2008) goals of chemical treatments are to add the least expensive sources of nitrogen to the residue and to break down the lignocellulose linkages, which will allow rumen bacteria to enter through the stem's outer sheaf. One chemical substance that is a member of the non-protein nitrogenous compound (NPN) group is urea. It has the advantage of being less expensive and can be used to replace real protein in ruminant diets as an alternate source (Benedeti *et al*., 2014). Urea treatment (as an example of chemical treatment) has been used to improve the feeding value and aimed to disrupt the lignin carbohydrate complex, which has been tested in attempts to improve the accessibility of structural carbohydrates to cellulolytic microorganisms. Urea is the most widely available, easily transportable in relatively small quantities, and safe in usage (Singh *et al*., 1998).

3) Biological treatment:

Several methods have been tried to improve the digestibility and usage of agricultural wastes; one of these methods is the use of biological treatments, which are necessary to improve the concentration of crude protein (CP) and degrade down lingo-cellulose into cellulose, hemicellulose, and lignin. It is commonly known that certain microbes, such as anaerobic bacteria, break down lignin in their cell walls and excrete the cellulose enzyme. Numerous biological treatments have been applied to this lingo-cellulosic material to enhance its nutritional content, palatability, and dry matter digestibility Morrison (1988) and Abd El-Aziz and Ismail (2001). Enzymes, yeast, fungi, and bacteria are examples of biological treatments. According to Weimer (1996), Each microbial species has an individual set of properties, such as the kinds and ratios of fermentation products produced, the substrates that are used, and the growth yield.

(Summarized from the reports of Adesogan *et al*., 2014 and Abdel-Aziz *et al*., 2015).

4) Feed additives:

As a result of industrial processing, some waste is produced and can be as a feed additive for non-conventicle roughage, for example of this material:

Some authors using variety level of molasses to improve different types of agriculture residues, for example, Eroni and Aregheore (2006) recommended that the best level of molasses ranged between 5-10% to treate Setaria Grass, AboBakr *et al*. (2020c) reported that addition of molasses for trimming waste was 6.1%, Abo Bakr, 2012 found that treated wheat straw by using 3% molasses and other additives led to improved nutritive.

Processing treatments:

Total mixed ratio (TMR) Technique:

A total mixed ration is a technique of feeding ruminants that combines feed ingredients to a specific nutrient content into a single feed mix (Fig. 1). The mix includes concentrate ingredients (grains, meals, feed additives, and others) plus roughages (hay, silage, straw, and others) the following feeds.A total mixed ration is a technique included different methods (mechanical, biological and addition of additives), thus, Abo Bakr (2006) prepared some fodder shrubs with concentrate feed mixture as TMR compared with the same ration with another form (roughage and concentrate as a solo), who found that improved some nutrients digestibility and nutritive in favor of the TMR group. Simoni *et al*. (2021), Observed that preparation of the hay-based as a TMR diet, may improve the efficiency of its degradation and digestion for almost nutrients.

Advantages of TMR Feeding:

Schingoethe (2017) summarized some advantages and disadvantages of the TMR technique for feeding animals as follows:

i. No choice among feeds is permitted (especially the flavor of unpalatable ingredients). As a result, every bite is as consistent, measurable, and as near to a nutritionally balanced meal as possible.
ii. Non-protein nitrogen compounds-particularly urea-are easier to feed and safer to consume as animal feed.
iii. Through TMR feeding, labor may be reduced.
iv. When cows switch from high-forage diets to concentrate diets just after giving birth, complete rations given *ad libitum* cause fewer digestive disturbances during the early stages of lactation.
v. A base of silage used for foraging helps to hide and dilute the flavor of undesirable substances.

Also, providing feed as TMR has nutritional benefits such as the possibility to easily use by-products from the food industry (Gill, 1979 and de Souza *et al*., 2019), home-grown protein sources, incorporated less palatable ingredients into the mix (Coppock et al*et al*., 1981) as well as increase daily total dry matter intake compared with feeding roughage and concentrates separately (Nocek *et al*., 1986 and Collier *et al*., 2018).

a. Collected chopped trimming waste of fruit trees into small pieces (1-3cm)

b. Mixing fibrous chopped materials with agro-industrial by-products

c. Crushed whole material with them by different machine to grinding it

d. Supplemented final mixture with some additives to become ready for animal nutrition

Fig. 1. Steps of total mixed ration (TMR) preparation.

Silage:

Silage is cut traditional green forages (berseem, corn, sorghum, and others) that are sealed in a silo without air and water (Fig. 2). however, with the availability of green vegetable waste, the scarcity and high prices of traditional green fodder, many procedures (e. g. ensiling) have been used to utilize and enhance untraditional forages (e. g. trimming waste and vegetable thrones). Ensiling of these materials appeared to be the most convenient processing method and led to improving the quality of forage resources and enhanced their acceptability for ruminant nutrition under the prevailing conditions of aridity in Egypt (Abo Bakr *et al*., 2020b).

1. Silo preparation (different forms)

2. Collection of forage

3. Transportation forage to the processing place

4. Chopping

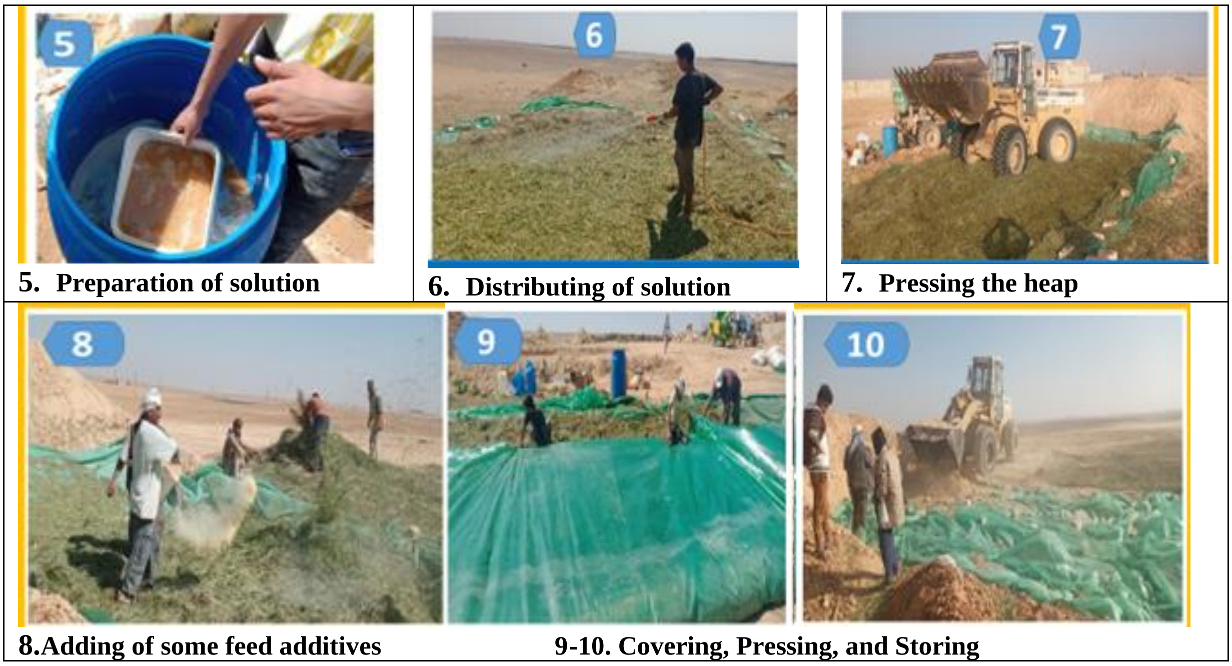

Fig. 2. Steps of silage manufacturing (Processing).

Covered stack manufacturing:

In this method (Fig.3), Agricultural residues (straw, Stover, trimming waste of fruits of vegetables, *etc*.) after mechanical treatment were treated with a solution consisting of 1-2% urea + 3% molasses + 40% water according to Chenost and Kayouli, (1997). It was mixed well and pressed into a silo (rectangular with dimensions of 2x4m and with a depth of 1.5m). It is advised to wrap the treated trash for thirty days using a polyethylene covering that is typically two millimeters thick. After that, the pile was turned upside down and well stirred each day as it dried in the sun for three days, allowing all the ammonia to be released and making it suitable for animal feeding (Abo Bakr, 2012).

Fig. 3. Steps of covered stack feed manufacturing.

Some studies applied agricultural residues by using virtues processing methods:

Gouda *et al*. (2022) Date palm leaf ensiling with organic acids (malic or lactic acid) as a feed for lactating Farafra ewes fed for 3 months under desert conditions. It is determined that feeding DPL ensiled with malic or lactic acid at 20 or 40% of the total diet DM enhanced daily energy-corrected milk output, fat-corrected milk production, efficiency of nutrient utilization, and quality of milk.

Abd El-Hay, (2020) conducted an assay laboratory trial to treat olive cake with different treatments (molasses, urea, sodium hydroxide, lime, biological additives) by using 12 Barki rams during digestibility trails and, after that, chose the best treatment by using 10 Barki lambs (two groups) were used in growth period (112 days) to test it in growing sheep performance. He found that the best treatment was biological additives called Cata pro® (biological treatment). There were no discernible variations in the live weights of the studied groups depending on body weight or daily body weight gain across the experimental meals. While the ewe lambs group that received the ration contained biologically treated olive cake had higher live body weight than the control. Compared to lambs fed a control ration that did not contain biologically treated olive cake, the average daily gain for the trial period was greater in the ration containing biologically treated olive cake by 28.42%.

To determine if there was any difference in the effect of utilizing it on the productive performance of Fifteen Zaraibi goats, 50% of dried orange pulp or dried citrus pulp (oranges, tangerines, or lemons) was substituted for the yellow maize grains in the control ration. The average daily milk yield during three months and feed efficiency for the control, dried orange and citrus pulp meals were 1.43, 1.49, and 1.52 l/day/doe, respectively, demonstrating the benefits of employing dried citrus or orange pulps. In any case, it might be advised that, in order to lower the cost of feed and enhance goat performance and milk production, dried orange and citrus pulps (lemons, tangerines, and oranges) can safely replace 50% of the energy sources contained in rations (Allam and El-Elaime, 2020).

Abd-Elgwad *et al*. (2021) investigated treated barley straw by bacteria *Cellulomonas Cellulases* (TBS) with condensed molasses soluble compared with clover hay to fed 10 Barki lambs (divided into two groups) fed for 150 days. The results showed that CP digestibility recorded a higher value as a result of bacteria treatment while other nutrient digestibility didn’t differ among all rations. In the same trend, the growing lambs' body weight gain and feed conversion did not vary between the groups. On the other hand, the economic feed efficiency was better for lambs fed treated barley straw by bacteria with the group that was soluble in condensed molasses being 15.3% greater than the group that was fed clover hay as a control. Hadhoud *et al*. (2021) evaluated replacing concentrates feed mixture with (30%) dry olive cake, olive cake silage, or olive cake silage that has been enzyme-treated with fibrin to fed 40 lactating Barki ewes for 9 weeks. They found that both silage (without or with fibrinolytic enzymes) of olives cake was significantly higher for daily milk production (15.08 and 17.21%, respectively) and energy-corrected milk (19.11 and 24.65%, respectively) as well as feed (milk yield/dry matter intake) efficiency (16.22% for both) in contrast to the control ration. It is generally assumed that an olive cake can replace 30% of the concentrate feed combination without adversely affecting performance; however, performance is improved when the olive cake is ensiled with or without fibrinolytic enzymes.

El-Hawy *et al*., (2019) pointed out adding mixtures of biological feed additives (ZAD or ZADO as a mixture of probiotics in forms a liquid or Powder, respectively) to rations containing Bean straw to feed Barki ewes (20 ewe/group) during 12 weels lactation period. They reported higher feed intake in biologically treated groups compared to control. In the same trend, during different physiological statuses, the body weight of ewes was significantly increased as a result of treatment. Also, the milk yield tended to increase in different biological treatment groups and consequently weaning weights and average daily gain were increased.

Kewan *et al*. (2019) applied two different biological treatments (*Saccharomyces cerevisiae* yeast or *Trichoderma reesei* fungus) to the stalks of moringa trees. In comparison to different group compared with the control (all groups involved 8 lamb and fed for 140 days), they found that intake from moringa tree stalks treated biologically (with fungi or yeast) increased by 4 and 2%, respectively. For the control, fungal, and yeast groups, the average daily increases were 173, 139, and 146g/head/day, respectively. Conversely, the experimental rations did not affect average dressing percentages. Additionally, when compared to the other treatments (fungi or control), the yeast treatment yielded the most economical feed efficiency.

Fayed *et al*. (2019) studied the impact of feeding biologically treated watermelon vines by (*Trichoderma reesei*), and how it affects the way productively fivty Barki lambs grow. Offered rations were 50% concentrate plus 50% berseem hay as a control (R1), R2, and R3 resaved lambs in R4 and R5 were fed 25 or 50% treated watermelon vine hay with *Trichoderma reesei* fungus, whereas the remaining lambs were fed 25 or 50% untreated watermelon vine hay with *Trichoderma reesei* fungi. They observed that the daily increase and total body weight gain data were similar between R4 (33.36kg and 198.57g, respectively) with those of control one (33.37 kg and 198.63g, respectively). In the same trend, the feed cost was decreased by 11.78for R4(which had 25 watermelon plants infected with fungus) in comparison to the control group's figure. When comparing R4's economic efficiency to the control group, it also increased by 23.64%. Lastly, the trial's findings suggest that to lower feed expenditures for developing lambs without negatively affecting their health or performance, biologically treated watermelon vines may be added to rations up to 25% (i.e., 50% in place of berseem hay).

According to Khir *et al*. (2015), trimming peach trees by-products treated chemically with 3% urea or biologically with a distinct strain of *Trichoderma fumgi* (reesei, viride, and reesei plus viride). They discovered that the growth performance of Ossimi lambs (6 lambs/group fed for 120 days) for both chemical treatment by urea and combined biological treatments was greater, at 46% and 19%, respectively, in terms of average daily gain (ADG) and total body weight gain. The best results were found with chemical treatment, and a similar pattern was shown for feed conversion and economic efficiency.

Kewan *et al*. (2021) cleared that treated trimming waste of mandarin trees supplemented by ZADO or yeast (as biological additives) to fed 48 lactating Barki ewes (16 each) for 14 weeks, the data indicated that ewes consumed substantially more feed overall. The same trend was observed for digestibility values for nutrients and feeding values of rations involving comparing biological additions to the control ration, there was a considerable increase. However, when compared to animals fed ZADO and the control group, animals fed diet yeast showed a significant increase in both the actual daily milk yield and the energy-corrected milk yield with group-fed ation including yeast.

Abo Bakr *et al*. (2020a) compared feeding (30 weaned Barki lambs divided to 3 groups and lasted for 4 months) mandarin tree-cutting waste that was supplemented with Bio-Magic (a biological product with a level 10 kg fresh matter/ton concentrate feed combination) to feeding Berseem hay as the control. In comparison to the control and untreated trimming waste of mandarin trees, they discovered that the average daily gains for lambs fed the treated trimming waste of mandarin trees group increased by 4% and 15.9%, respectively. The treated pruning waste of mandarin trees also had the best feed conversion and economic efficiency.

By-products of pruning grape trees were subjected to five treatments each has 6 Osimi lambs by Phillip *et al*. (2014), they using 3% urea, *Trichoderma reesei*, *Trichoderma viride*, and *Trichoderma reesei* with *viride*. They discovered that fungal treatments followed by chemical treatments with 3% urea, enhanced growth performance for both average daily gain (ADG) and total body weight gain. Untreated pruning grape tree by-products showed the lowest value. Similar to this, when compared to roughage that had not been treated, biologically followed by chemical treatment resulted in higher feed conversion and economic feed efficiency.

Galab *et al*., (2021) study examined the impact of experimental feeding (lasted 135 days) Forty-nine Ossemi male lambs that were developing on a combination of locally sourced feed sources that included discarded dates and palm leaves on their growth performance. The control meal, which contained no wasted dates and no palm leaves, was given to the first group of lambs. An experimental diet comprising 7.5% discarded dates and 6% palm leaves was fed to the second group of lambs, and an experimental ration consisting of 15% discarded dates and 12% palm leaves was fed to the third group of lambs. When compared to the other treatment, lambs fed a diet containing 7.5% discarded dates and 6% palm leaves (T2) exhibited a substantial improvement in terms of final body weight, total weight growth, average daily gain, and feed conversion ratio.

Rabee *et al*. (2021) prepared three rations to fed 36 growing male Barki lambs (three equal number groups). Rations offered as total mixed ration (TMR) form which contained a traditional concentrate mixture as a control (R1), the second ration (R2) consisted of an untraditional concentrate mixture that involved agro-industrial by harming products (olive cake, discarded dates), while the third ration contained R2 plus date palm fronds (as a roughage) enriched with 15% molasses (R3). Compared to the animals in the R1 group, they discovered that the R2 group's animals had lower relative growth rates and higher dry matter consumption.

Despite having the lowest dry matter intake, the animals in the R3 group grew at a relative rate that was almost 87.6% higher than that of the R1 group. They finally came to the conclusion that R3 supplemented with leftover dates, olive cake, and date palm fronds) represents a workable fix for the shortage of common feed supplies and may take the place of the traditional feed mixture.

Aziz, (2020b) examined the performance of Forty ewes assigned into four groups and lambs when fed berseem hay versus date palm tree leaves that had been dried or silage that had been cultured with or without bacteria. Who demonstrated that treated silage of date palm tree leaves increased Ewes' body weight and overall growth as their pregnancy and breastfeeding progressed, with negligible differences from the control group. Also, treated palm tree leaves silage without or with bacteria led to increased milk yield during period (12 weeks) by 12.47% and 21.67%, respectively than dried date palm leaves. On the other hand, Average daily gain showed no significant differences among the lambs' group fed different forms of date palm leaves (dried and silage untreated or treated with bacteria) and control. Generally, from the previous observation, it can be said feeding bacterial-treated date palm leaf silage treated with bacteria is preferable to dry or untreated forms and it has the potential to take the place of hay in sheep's diets under various physiological conditions.

Eighteen crossbred lambs (6 head/group) were fed three different rations by Mahrous *et al*. (2019). The first ration consisted of untreated olive tree by-products (control ration); the second contained treated by-products with EM1 (a product of the EMRO Organization in Japan); and the third contained treated by-products with El-mofeed solution. According to the findings, diets including treated olive tree by-products had higher feeding values and nutrient digestibility than roughage that had not been treated. Growth performance concerning average daily gain (ADG) and total body weight growth was enhanced by El-mofeed, a chemical therapy, and EM1, a biological treatment. Following the same pattern, biological treatment was shown to have the highest feed conversion and economic efficiency.

Galal *et al*. (2016) investigated the impact of substituting berseem hay with strawberry vine hay at varying percentages (30%, 70%, and 100%) and the potential to use this residue as an alternate source of roughage for 28 Damascus healthy lactating does in hot weather. and how it affects output constructively. They found that while the other groups' feed intake was almost identical, the lowest results were obtained when high replacement level 100% strawberry vine hay was used. Both the control and 70% strawberry vine hay had almost identical milk yields. This group exhibited the highest economic efficiency in a similar trend. The ratiowith 30% strawberry vine hay had the highest average daily milk output and the best feed conversion. G2 (70% strawberry vine) had the greatest average daily milk yield and the highest fat-fat-corrected milk (FCM) percentage.

According to study by Abd El-Hay *et al*., 2012 the performance of developing male lambs (27 head fed for 180 days) was examined when 47% crushed date stone or a similar percentage of water-soaked date stone was substituted. They discovered that while the final body weight and total body weight growth of the lambs fed the control ration which contained yellow corn were higher than those of the other groups which contained treated date stone total feed consumption did not differ substantially across the lamb groups. In contrast, lambs given the treated ration had a lower feed cost per kilogram rise in live body weight than lambs fed the control diet. As a result, the final margin improved for lambs fed the treated date stone by almost 17% when compared to lambs fed the control ration.

CONCLUSION

From the previous research work and based on the huge amount of agricultural waste and agro-industrial products, it could be stated that efforts were carried out to exploit such ingredients as non-conventional feedstuff in livestock production, particularly under the desert and marginal environmental conditions of Egypt. Further research studies must be extended to throw some light on the secondary metabolites that may be found in these ingredients due to their negative impacts on the productive and reproductive performance of animals. The recent approaches of biotechnology to enhance the utilization of agricultural residues must be taken into consideration. Finally, Egypt as one of the developing countries involved in the climate change convention gives really special interest to this issue at least to minimize the environmental pollution to cope with the climate change issue.

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المخلفات الزراعية واستخدامها كمصادر علف بديلة في مصر: مقالة مرجعية

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يتزايد الطلب العالمي على اللحوم منذ عقود. وكما تبين احصائيات منظمة الأغذية والزراعة للأمم المتحدة (الفاو)، فقد زاد إنتاج اللحوم العالمي خمسة أضعاف منذ الستينيات. وتوقعت الفاو (٢٠٢٣) أن تصل كمية اللحوم المنتجة إلى حوالي ٣٦٤ مليون طن. ونتيجة للتزايد السكاني العالمي، يجب زيادة إنتاج اللحوم ليصل إلى ٤٩٨ مليون طن في عام ٢٠٥٠. من ناحية أخرى، اقترحت الفاو أيضاً أن الحد الأدنى لنصيب الفرد من البروتين الحيواني هو ٢٩,٣ جرام بروتين/فرد/يوم. وللأسف يبلغ نصيب الفرد من البروتين الحيواني اليومي في مصر ١٩,٢ جم فقط. وتعتبر مكونات الأعلاف من أهم العوامل التي تحد من تطور وربحية الإنتاج الحيواني. وتمثل الأعلاف أكثر من ٨٠٪ من تكلفة الإنتاج الحيواني. فعلى الرغم من وجود كمية هائلة من المخلفات الزراعية في مصر (٢٩,٦٤٥ مليون طن)، والتي تنتج خلال الممارسات الزراعية إلا أنها قيمتها الغذائية منخفضة. لذلك هناك العديد من الطرق للإستفادة من هذه المخلفات الزراعية الضخمة بأي طريقة أخرى صديقة للبيئة. فيمكن أن ينتج من هذه المخلفات العديد من المنتجات المفيدة والعالية فى محتواها من الطاقة مثل إنتاج السماد (الأسمدة الحيوية)، وإنتاج الغذاء (زراعة المشروم على المخلفات الزراعية)، وإنتاج الطاقة (البيوجاز والبيوديزل والبيوإيثانول)، والعديد من المواد الكيميائية الحيوية وإنتاج الأعلاف الحيوانية. وهذه الدراسة تلقى الضوء على بعض الطرق المختلفة لإستغلال المخلفات الزراعية كمصادر علفية بديلة خاصة في ظل الظروف البيئية الصحراوية والهامشية في مصر.