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Din sumar

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CUPRINS

TEHNOLOGIE / TECHNOLOGY

ANALYSIS OF TECHNICAL EQUIPMENT USED WITHIN THE CULTURE TEHNOLOGY OF ENERGY PLANT MISCANTHUS

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REZUMAT

Tehnologia de cultură a plantei energetice Miscanthus cuprinde totalitatea lucrărilor agrotehnice necesare procesului de producţie pentru înfiinţarea, întreţinerea şi recoltarea culturii.

Utilizarea unor tehnologii moderne cât şi a unor echipamente performante va avea utilitate practică pentru fermierii care vor să investească în culturi energetice atât în scopul obţinerii de biomasă cât şi în scopul comercializării rizomilor în vederea înfiinţării de noi culturi.

ABSTRACT

The culture technology of energy plant Miscanthus comprises all agro-technical works necessary in the production process for establishing, maintaining and harvesting the culture.

The use of modern technologies as well as of high-performance equipment will have practical utility for the farmers who want to invest in energy cultures both in order to obtain biomass and to sell rhizomes for establishing new cultures.

KEYWORDS: technology, Miscanthus, equipment, rhizomes, establishing, maintaining
CUVINTE CHEIE: tehnologie, Miscanthus, equipment, rhizomes, înfiinţare, întreţinere

1. INTRODUCTION

One of the most efficient solutions to reduce CO_2 emissions is the use of renewable energies, characterised by an extremely low level of these emissions.

The main sources of renewable energy in Romania may be: biomass, solar energy, wind and geothermal energy. Regarding biomass, the best perspectives for bioenergy production are the dedicated cultures. Miscanthus culture is among the most advantageous cultures for heat and bioethanol production.

The energy potential of the plant can be explored in three main directions: to obtain bioethanol, biogas and solid biomass (chopped matter, pellets or briquettes), then converted into energy through thermal processing.

The results of research made so far lead to the conclusion that: 1 ha of Miscanthus can produce an average amount of 23-25 tons of dry substance, 10-16% humidity, with calorific value equivalent to that of 14 tons of coal or 10 tons of oil. Miscanthus is one of the most efficient cultures. Net calorific value, in respect to dry biomass is 17 MJ/kg or 4.75 kW/kg. [4]. The biomass obtained can be used both for producing electric energy and/or heat and as fibre source in different industries. Miscanthus genus contains 15 species of perennial grasses originating in tropical and subtropical regions of Africa and southern Asia, only one species (M.sinensis) being spread northward in the temperate zone of eastern Asia. The plant that has been used as a biofuel in Europe since the early 1980s is a triploid sterile hybrid between *M. sinensis* and *M. sacchariflorus* and is called *Miscanthus giganteus*. [2], [3]

M. sinensis *M. sacchariflorus* *M. giganteus*
Figure 1: *Miscanthus main species*

In England and Germany, the best performances were achieved by *Miscanthus giganteus*. In Portugal, although *Miscanthus giganteus* had very good results, the best ones were given by a hybrid of *Miscanthus sinensis*. Also a series of *Miscanthus sinensis* hybrids registered the best results for the conditions in Sweden and Denmark. The authors of the study concluded that *Miscanthus sinensis* has a special capacity to perform in varied climate conditions, while for central Europe, *Miscanthus giganteus*, is the best performing genotype.

The studies carried out in Great Britain showed that the key elements for obtaining competitive Miscanthus crops are: the number of sunny days, temperature and the available water in the soil. Annual variations of these factors also determine variations in the crop size.

Miscanthus cultivation has a positive impact on soil erosion processes. One of the significant factors that contributes to intensifying soil erosion is intensive agriculture. The big number of mechanised works, necessary for most conventional agricultural cultures (destined to food industry), destroy soil texture and structure thus accentuating erosion processes generated by environment factors (water, wind). It is expected for Miscanthus introduction in the culture to reduce sharply these phenomena (perennial plant, reduced number of soil works, high density per hectare, etc.).

MATERIAL AND METHODS

Miscanthus is an herbaceous perennial plant which, being sterile, it is multiplied just vegetative, by dividing rhizomes. Brown rhizomes are irregularly shaped, with protuberances and even strong ramifying branches, their thickness varying between 7 and 12 mm. For field planting young rhizomes are used (three years at the most), healthy, with no mechanical damage, the length of 10-15 cm and weight of 40-60 g, with at least 3-4 viable buds.

***Figure 2**: Miscanthus rhizomes* [1], [4]

RESULTS

The mechanisation technology for establishing and maintaining the Miscanthus culture ensures that all component machines and technical equipment be correlated from technical, economic and organisational point of view in order to obtain maximum agricultural products at minimum costs.

The main works within the technology for establishing, maintaining and harvesting Miscanthus culture can be grouped, depending on the technological process applied, in:

- the technology for establishing and maintaining the Miscanthus culture requires the following agro-technical works: *organic fertilizer application, plowing, disking, planting, herbicide application, emergence irrigation;*
- the technology for harvesting and transporting the Miscanthus culture requires the following agro-technical works: *dry stems harvesting, transport.*
- the technology for harvesting the Miscanthus culture requires the following agro-technical works: *vegetable remains chopping, rhizomes harvesting, calibration, transport, conditioning, packaging and storage.*

The technical equipment that is part of the technology for establishing and maintaining the Miscanthus culture is presented below:

Organic fertilizer application

The machine for solid organic fertilizer application MG 5 is destined for transporting, grinding and applying manure, fermented and unfermented, on fields with up to 6° slope. MG5 machine works in aggregate with 65 HP wheeled tractor.

***Figure 3:** Machine for solid organic fertilizer application MG 5* [9]

Characteristic	Value
Manure capacity, *t*	5
Conveyor	with scrappers arranged on chain
Conveyor driving	mechanical/hydrostatic
Application effective width, *m*	3.5
Effective application width, *m*	8
Average working capacity, *ha/h*	1.95...2.53
Specific fuel consumption, *l/ha*	20

Plowing

Mounted plow PP4-30M, in the process of fabrication with S.C. MAT S.A. Craiova, performs autumn plowing which consists in furrow cutting and lateral displacement in the same time with overturning and grinding it. The plow PP4-30M works in aggregate with 65-80 HP tractor, on flat or up to 6° slope fields. The plow works properly on all soil types and can perform plowing depths of max. 30 cm.

***Figure 4:** Mounted plow PP4-30M* [5]

Characteristic	Value
Manure capacity, *t*	5
Conveyor	with scrappers arranged on chain

Conveyor driving	mechanical / hydrostatic
Application effective width, *m*	3.5
Effective application width, *m*	8
Average working capacity, *ha/h*	1.95...2.53
Specific fuel consumption, *l/ha*	20

Disking

The *light disc harrow GDU 3.3*, manufactured by S.C. MAT S.A. Craiova, is used for sandy and medium soils for preparing the field after plowing in order to destroy weeds, lump breaking, soil loosening and levelling but also for preparing the seedbed. GDU 3.3 harrow works in aggregate with 65 HP tractor.

Figure 5: *Light disc harrow GDU 3.3* [5]

Technical characteristic	Value
Type	mounted
Working width, *m*	3.3
Maximum working depth, *mm*	60...120
Number of batteries	6
Batteries disposal	"X"
Distance between discs, *mm*	185
Working speed, *km/h*	5...8
Minimum transport clearance. *mm*	220
Mass, *kg*	975
Working capacity, *ha/h*	1.3...1.8
Specific fuel consumption, *l/ha*	5.1...6.8

Planting

The machine for planting Miscanthus ETPM4, produced by S.C. MECANICA CEAHLAU S.A. Piatra Neamt, works in aggregate with 65 HP wheeled tractors, endowed with three-point suspension system.

Figure 6: *Machine for planting Miscanthus ETPM4* [6]

Technical characteristic	Value
No. of planted rows	4
Distance between rows, *mm*	500…1000
Overall dimensions Lxlxh, *mm*	1520x4200x2780
Working width, *m*	2.5...4
Planting depth, *cm*	8...12
Effective working capacity, *ha/h*	0.6...0.76
Specific fuel consumption, *l/h* (*l/ha*)	4.5..4.8 (7.5...6.6)

Herbicide application

Herbicide sprayer MET 1000, which is in mass production at S.C. MAT S.A. Craiova, is of type trailed by 65HP tractor; it is destined to fight perennial weeds and to apply seasonal phyto-sanitary treatments.

Figure 7: *Herbicide sprayer MET 1000* [5]

Technical characteristic	Value
Tank capacity, *l*	1000
Water tank capacity, *l*	100
Maximum working width, *m*	12
Pump flow, *l/min*	70
Working pressure, *bar*	1 ... 5
Spraying fineness, *µm*	150...450
Ground clearance, *mm*	350
Constructive mass (no liquid in the tank), *kg*	525
Spraying system	hydraulic
Nozzles type	flat spray P2-110°
Solution norm, *l/ha*	35...480
Working capacity, *ha/shift*	15...20
Fuel consumption, *l/ha*	7.8

Chemical fertilisers' application

Fertilising machine MA 3.5A, produced by S.C. MAT S.A. Craiova, is made for transporting and spreading amendments and solid chemical fertilisers, on fields with a slope of up to 6°. Machine MA 3.5A works in aggregate with 65 HP wheeled tractor.

Figure 8: *Fertilising machine MA 3.5A* [5]

Characteristic	Value
Type	semi-mounted
Body volume, *m^3*	2.2
Number of centrifugal discs, *piece*	1
Working width, *m*	5…18

Working speed, *km/h*	6...8
Constructive mass, *kg*	1145
Average working capacity, *ha/h*	4.75....5.37
Specific fuel consumption, *l/ha*	8,5

Emergence irrigation

Company LEGMAS Navodari produces *the irrigation installation IAFT 300 T* destined to work flat fields, with local slopes, in a direction transverse to the driving one, of up to 5% and without obstacles (ditches, trees, high-voltage power lines, etc.)

Figure 9: *Irrigation installation IAFT 300 T* [7]

Characteristic	Value
Watering norm provided, m^3/ha	200-1000
Installation flow rate, m^3/h	46.5-55
Turret rotation angle, *degrees*	360
Working capacity ha/cycle (m^3/ha) t=12 days , n=600 m^3/ha	19.8
Watering width, *m*	54
Watering length, *m*	310
Hydrant pressure required, *bar*	2.5-4.5

Dry stems harvesting

Company S.C. MECANICA CEAHLAU S.A. Piatra Neamt produces *Miscanthus harvesting machine CRM*, which performs field harvesting, chopping and loading of Miscanthus plants in the transportation means.

Figure 10: *Miscanthus harvesting machine CRM* [6]

Characteristic	Value
Equipment working width, *m*	1.6
Theoretical chopping length, *mm*	10-40, in 6 steps
Chopping height, *mm*	120-150
Harvesting machine working speed, *km/h*	5.8-6.3
Working capacity for Miscanthus harvesting, *t/h*	7.06-7.9

Miscanthus chopped stems transport

Under the current conditions in our country, the chopped mass transport can be made with *agricultural dump trailers* of 5 tons or 7 tons (fig. 11), existing in the production, trailed by tractors U 650 M.

Figure 11: *Agricultural dump trailers*

Characteristic	Value	
	5 t trailer	7 t trailer
Trailer net volume, m^3	6.8	9.5
Trailer net volume with capacity increase equipment, m^3	11.2	14.2
Transport maximum speed, *km / h*	25	25
Loading capacity for Miscanthus chopped matter, *kg*	850	1100

Vegetable remains chopping

In our country, the equipment in the field of *vegetable remains choppers* are produced and sold by different companies, among which PreMagro Oradea.

Figure 12: *Vegetable remains chopper* [8]

The main technical and functional parameters of the vegetable remains chopper TRV – 1.8 are presented in the table below:

Characteristic	Value
Working width, *cm*	180
Chopping height, *cm*	0-18
Number of knives, *N°*	60 30 60
Mass, *kg*	600

Rhizomes harvesting

Technical equipment for harvesting Miscanthus rhizomes ERM is of type mounted on the 3-point suspension mechanism of 70…80 HP wheeled tractors and works in fields with slope accessible to tractors.

Figure 13: *Technical equipment for harvesting Miscanthus rhizomes ERM* [1], [2], [3], [4]

Technical characteristic	Value
Working width, *m*	1.2
Working depth, *cm*	maximum 25
Separating conveyor operating mode	hydraulic
Overall dimensions Lxlxh, *mm*	2090x1590x1395
Ground clearance, *mm*	350
Mass, *kg*	565
Effective working capacity, *ha/h*	0.44
Specific fuel consumption, *l/ha*	17.66

Miscanthus rhizomes transport

In our country, Mat Craiova produces *single axle dump trailer R02* having a net load of 3500 Kg, that can work trailed by a tractor U650.

Figure 14: *Single axle dump trailer R02* [5]

Technical characteristic	Value
Net load, *kg*	3500
Dumping installation	hydraulic
Trail dumping angle: - back, *degree* - lateral (left, right), *degree*	 45 36
Constructive mass, *kg*	1120

Manual c***onditioning***;

In order to maintain the viability of the rhizome for the longest period possible, the following operations are carried out:

- non-viable rhizomes are identified and removed;
- they are moistened by tap water spraying for supplementing the water reserve;

Manual ***packing***;

For storage the rhizomes are packed in sealed plastic (bag) to avoid losing humidity.

Storage

Cold storage is made to maintain the success rate of rhizomes emergence in view of further planting when the period between the harvest time and the planting time is longer than two weeks. Rhizomes can be stored in sealed containers to avoid dehydration. The storage temperature is < 4°C.

CONCLUSIONS

- One of the most efficient solutions to reduce CO2 emissions level is the use of renewable energies, characterised by an extremely low level of these emissions;
- Miscanthus plant, as renewable resource produces an amount of 15-20 t/ha dry substance, has a perennial growth of 10-15 years, uses efficiently the nitrogen, water and other resources, is resistant to diseases and, for maintenance, requires few fertilisers, pesticides and other chemicals. Net calorific value, relative to dry biomass, is 17 MJ/kg or 4.75 kW/kg;
- The use of modern technologies as well as of high-performance equipment will have practical utility for the farmers who want to invest in energy cultures both in order to obtain biomass and to sell rhizomes for establishing new cultures.

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CONSIDERATIONS ON SOLAR ENERGY APPLICATIONS IN AGRICULTURE

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REZUMAT
În această lucrare sunt prezentate aplicaţiile energiei solare în agricultură, precum şi importanţa panourile fotovoltaice în ceea ce priveşte furnizarea de electricitate a locaţiilor aflate la distanţa, cum ar fi exploataţii agricole, ferme, livezi şi alte operatiuni agricole. De asemenea, pomparea apei reprezintă una dintre cele mai simple, şi adecvata în acelaşi timp utilizare a panourilor fotovoltaice. În acest sens, INMA a realizat un sistem de pompare a apei şi un sistem automat de irigare bazat pe tehnologia picurării.

ABSTRACT
This paper presents solar energy applications in agriculture as well as the importance of photovoltaic panels in supplying electricity to remote locations such as agricultural exploitations, farms, orchards and other agricultural operations. In the same time, water pumping is one of the simplest and most adequate uses of photovoltaic panels. In this respect, INMA created a water pumping system and an automatic irrigation system based on dripping technology.

KEYWORDS: solar energy, drip irrigation, photovoltaic panels, solar water pumps
CUVINTE CHEIE: energie solară, irigaţii prin picurare, panouri fotovoltaice, pompe de apa solare

1. INTRODUCTION

Nowadays, when the energy issue is more and more important and environment protection has become a requirement of the society, efforts have also been intensified to develop technologies capitalising non-conventional energies (solar, wind, geothermal, etc.). Solar energy has made significant improvements in all sectors of industry today. There are many sectors that rely on the benefits of the sun including agriculture. The productivity of these sectors depends on the amount of energy they receive from the sun.

Solar energy is the radiant energy produced in the Sun as a result of nuclear fusion reactions. It is transmitted to Earth through space as energy quanta called photons, which interact with the atmosphere and the Earth's surface.

The potential of solar energy use in Romania is relatively important as it can be seen in Figure 1, which represents maps of global solar radiation. There are areas where the amount of solar energy reaches 1450-1600kWh/m^2/year, the Black Sea coast and Dobrogea as well as in most part of southern areas. In most regions of the country, the amount of solar energy exceeds 1250-1350 kWh/m^2/year.

In general, there are two types of solar systems: those converting solar energy into electricity and those converting solar energy into heat. Both have many agricultural applications, making life easier and helping to increase productivity.

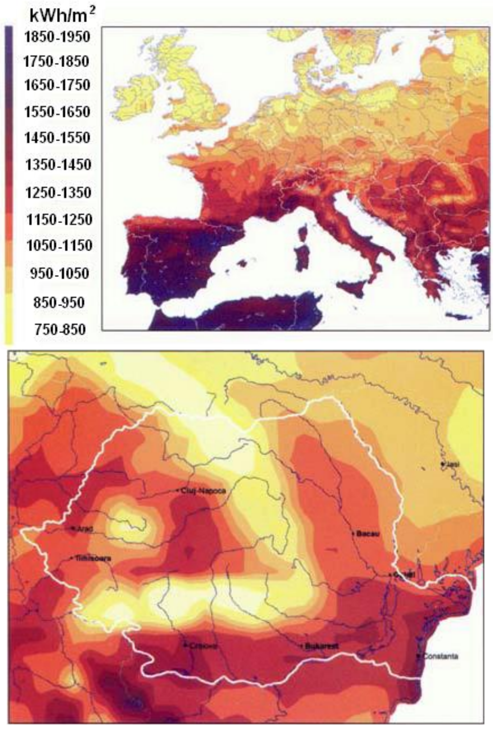

***Figure 1**: Map of solar radiation intensity in Europe and Romania*

Photovoltaic panels (fig. 2) are devices capable of transforming solar energy into electricity. Photocell allows the direct conversion of light energy into electricity, the operating principle being based on the photoelectric effect. The conversion is static and clean, that is why this way of producing electricity is environmentally friendly. The basic element of a photovoltaic system is the solar cell. The direct conversion of sunlight into electricity is called the photovoltaic. The yield of such panels is between 8-20%, depending on the solar radiation absorption degree [3].

Photovoltaic panels are very economical in terms of providing electricity at remote locations such as agricultural exploitations, farms, orchards and other agricultural operations. A location is considered “remote” even if it is 15 m away from an existing energy source. [6]

***Figure 2**: Photovoltaic panels* [3]

It is to be mentioned that the performance of photovoltaic panels is temperature-dependent. Thus, as the temperature increases, the efficiency of photovoltaic panels to convert solar radiation energy into electricity decreases. It can be considered, as indicative value, a reduction in efficiency of photovoltaic panels by 0.3% for each degree of temperature rise. In general, the electrical performance of photovoltaic panels is indicated at 25°C. It is obvious that from this point of view, the most efficient solar energy conversion into electricity is carried out in space where the temperature is close to 0K.

Figure 3 presents a system for producing and using direct current with the help of photovoltaic panels.

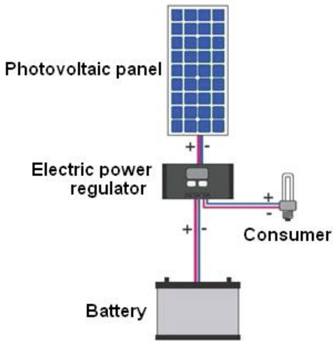

***Figure 3:** Photovoltaic panel system for producing direct current* [10]

This type of application could allow for example providing electric lighting, with DC bulbs, in buildings situated in isolated areas, lacking electricity.

Figure 4 presents a system for producing and using direct and alternating current at the same time with the help of photovoltaic panels. [7]

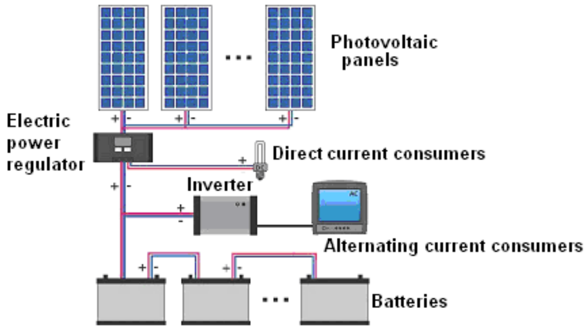

***Figure 4:** Photovoltaic panels system for producing direct and alternating current at the same time* [7]

Taking into account that such a system needs higher electric power, usually specific to DC consumers, it is necessary to use a larger number of photovoltaic panels, while the number of batteries is also larger so that the system could ensure maximum electric power, for as long as possible, before the battery is discharged.

We must also mention the obligatory presence in such a system of an equipment called inverter, which converts direct current into alternating current. [7]

Photovoltaics can be much cheaper than installing an electric power line and transformers; they can be used in applications such as electric fences, constructions lighting, water pumping, or for animal watering and crop irrigation. Using solar panels is more indicated in agriculture than using generators or wind turbines, especially due to maintenance (weatherproof, longer distances to specialized units, lack of qualified personnel for supervision). [6]

Another use of photovoltaic panels is supplying electric fans for air circulation. Modern poultry and pig farms doubled or even tripled production by animal breeding in enclosed spaces.

***Figure 5:** Photovoltaic panels used for farm ventilation* [5]

Another use of photovoltaics is the lighting in farm buildings. Running network electric cables can be a quite expensive alternative, as working hours and productivity can significantly improve in an illuminated room. This is especially valid for those who use their evening hours for equipment repair and maintenance operations. Photovoltaic systems can be a better solution at the expense of conventional lighting, flashlights and fossil fuel lamps. In addition, they provide more light, quality light and don't emit smoke, [8].

Other uses of photovoltaics in farms and orchards are: supply of animal feed (Fig. 6) and handling equipment, refrigeration products, animal feed equipment, compressors and pumps for fish farms, electric fences for animals, charging batteries.

Figure 6: *Photovoltaic panels used for animal feed* [2]

Also one of the easiest and adequate at the same time use of photovoltaic panels is water pumping. From crop irrigation to water storage for use in farm life, water supply photovoltaic systems meet a variety of needs. Most of these systems have the advantage of storing water for use at times when there is no sun, thus eliminating the need for batteries, enhancing simplicity and lowering overall costs of the system.

MATERIAL AND METHODS

Water supply has always been a problem especially when electricity is not available. Individual irrigation systems that use this technology proved to be the ideal solution and are increasingly used in agriculture. These systems use submersible or surface pumps. Essential in these applications are direct current pumps which have very high yield, using a very small amount of electric energy for water pumping. Submersible solar water pumps are used to extract water from wells drilled at small-medium depths. In Figure 7, a water pumping system with submersible pump is shown.

Surface solar water pumps are used for recirculating water in fish ponds, aerating fish ponds or lakes or irrigating agricultural surfaces from surface water basins. Figure 8 shows a water pumping system using a surface pump (Figure 8).

The advantages of solar water pumps are that they can be installed anywhere, don't require the existence of electricity network, are easy to install and configure.

The disadvantages of solar water pumps are that when powered only by photovoltaic panels, the pumps function only during the day when photovoltaic panels produce electric energy, so that the total water volume for 24 hours must be calculated to be pumped out during the day (sun-light).

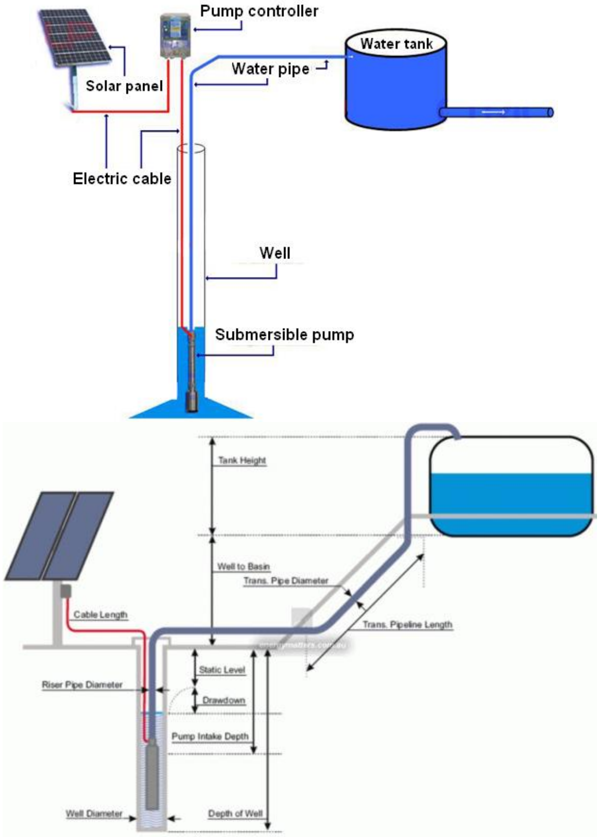

Figure 7: *Water pumping system with submersible pump* [7], [8]

Figure 8: *Surface pumping system PS1200* [8]

Also, in the days with thick clouds, pumps performances are reduced.

Photovoltaic installations with solar water pumps have, in general, only two components: photovoltaic panels and the submersible pump. Photovoltaic panels' life is of approx. 25-30 years.

The pump’s life duration is given both by the functioning conditions (the quality of drilled well, of the water and the level of impurities) and by the materials the pump is made of.

Another important feature of solar water pumps is to have variable speed. Basically when clouds appear and the available electric energy decreases, the solar water pump doesn’t stop running but it lowers functioning speeds bringing in a smaller amount of water than the standard one, but still functioning. As these pumps accept power both from photovoltaic panels, and from a generator or an electricity network, it is possible that in the days you want to supplement operating hours to connect a generator to the pump and thus the pump may work also at night.

The investment in solar water pumps is amortized within 2 years of activity. In general, investments in agriculture are medium and long term investments. In the case of a fruit tree plantation or of permanent crops, positive economic results are expected in a few years, when the trees begin to bear fruit and the crop reaches maturity. In this case, solar water pumps show their true value because after the investment in these pumps is amortized (1 year - 2 years), the operating costs are zero. [4]

RESULTS

An example of the use of photovoltaic panels is also found in the water pumping system (Fig. 9) within INMA Bucharest institute where, in the hot periods when water demand is high, photovoltaic panels have maximum efficiency. If the necessary water needs to be covered permanently (day / night, clear sky / cloudy) and there isn’t the possibility for water accumulation for this time interval, the energy generated by photovoltaic panels will be accumulated in batteries. If the necessary water can be covered by storing it in tanks, the system should not contain also the batteries for energy storage.

Figure 9: *Solar technology application for creating water pumping systems (Source: INMA Bucharest)*

Also, INMA created an automatic irrigation system based on dripping technology, shown in Fig. 10.

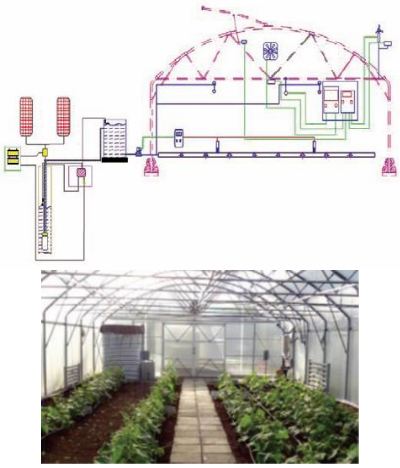

Figure 10: *Solar technology application for making dripping irrigations (Source: INMA Bucharest)*

In modern agriculture (be it vegetables in the solarium, in the field, fruit trees, vines or cereals), water control is crucial, given that we want to obtain crops that are able to support a population that registers a rapid growth. [1]

CONCLUSIONS

- Photovoltaic panels are very economical in terms of providing electricity at remote locations such as agricultural exploitations, farms, orchards and other agricultural operations.
- Solar energy has made significant improvements in almost all sectors of industry today. The productivity of these sectors depends on the amount of energy they receive from the sun.
- The advantages of solar water pumps are that they can be installed anywhere, don’t require the existence of electricity network, are easy to install and configure.
- Using a photovoltaic system to power the electric consumers of the installation for drip irrigation makes a contribution to environment protection by conserving the resources of polluting classical fuels and by using the inexhaustible, free and clean solar energy.

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CONSIDERATIONS REGARDING TO HIGHER CAPITALIZATION POSIBILITIES OF RHUBARB CULTURE

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REZUMAT

In lucrare este prezentat un studiu in care sunt sintetizate aspecte privind potentialul extraordinar pe care il are cultura de revent (rubarbă) pentru valorificarea ca plantă medicinală, în diferite specialităţi farmaceutice precum şi în procesarea traditionala. De asemenea sunt prezentate valorile nutriţionale şi principiile active ale plantei precum si actiunea data de acestea.

ABSTRACT

In the paper is presented a study that summarizes aspects of the extraordinary potential of rhubarb for capitalization as a medicinal plant in various pharmaceutical specialties, as well as in traditional processing. Also, are presented nutritional and active principles of plant, as well as the given effects by those.

KEYWORDS: medicinal plant, active principles, rhubarb, capitalization
CUVINTE CHEIE: plantă medicinală, principii active, revent, valorificare

1. INTRODUCTION

Medicinal plants have been used since ancient times in human body fight with the disease. Modern science has now demonstrated the subtle effect they have on the body. In search of those necessary for living, the man noticed that some plants, put on wound, relieved the pain, encouraging their scarring, and others, consumed, healed some diseases [2].

The rhubarb (rheum rhabarbarum L.) (figure 1) is one of the oldest medicinal plants known by mankind, originating in north-eastern China and Tibet. In China, it was used for 2,700 years for purgative effects and in Europe it is known for 400 years, first in Germany and later in England. Plants are perennial, with strong rhizomes and much thickened roots, depositary of reserve substances. On account of these reserves, the plant recovers annually the rosette of leaves, whose thickened petiole and 40-46 cm long is springy harvest, 30 days after the soil has thawed. Plant vigour increases with age, in conditions of close dependence among the leafs surface, which measures up to 1m in length and the rhizomes that support the continuity of productive vegetation for about 25 years [3].

In our country, the rhubarb is less known, being cultivated in Transylvania zone, at high altitudes. In Romania, the rhubarb plant is also known under popular name of rabarbura and was used mostly for children body strengthen (rhubarb compote) and for digestion relief.

There are more scientifically names for rhubarb, namely:

- ✓ Rheum rhabarbarum (rheum x hybridum) – garden rhubarba, eatable;
- ✓ Rheum rhaponticum – “false” rhubarba;
- ✓ Rheum officinale – “medicinal”rubarba;
- ✓ Rheum palmatum –„turkish rhubarb”;
- ✓ Rheum acuminatum, Rheum australe;
- ✓ Rheum ribes – some ornamental rhubarba types [6].

The rhubarb is cultivated for the leaf petiole, has a sweet-sour taste, is suitable for the preparation of compotes, jams and other desserts. Rhizomes and roots serve as a starting material from which various pharmaceutical specialties with laxative and purgative properties are prepared [1].

The rhubarb has also healing properties, appetizing and cholagogic and stimulates blood circulation. The decoction of the rhubarb root has antibacterial action against Staphylococcus aureus. It is used in the form of decoction, infusion and tincture, against constipation, gastric atony, hepatitis, dysentery, dyspepsia, diarrhea. External is used for pharyngitis, laryngitis, contusions, burns and mouthwash for paradontosis.

***Figure 1:** Rhubarb plant [3]*

The rhubarb is a very tall and powerful plant, sometimes it can grow up to 2 m. Leaves (Fig. 2, a) are also vigorous and strong, being highly appreciated for their anti-inflammatory qualities.

The rhubarb petioles (Fig 2, b) have a colour that can range from light pink to reddish-violet. The darker is colour, sourer it is. The petioles of rhubarb contain many organic acids, especially malic and citric acids, sugars, pectin and mineral substances (potassium, calcium, phosphorus, magnesium, iron), vitamins C, PP, E, K, routine, carotene. The petioles of the rhubarb contain many organic acids, especially malic and citric acids, sugars, pectin and mineral substances (potassium, calcium, phosphorus, magnesium, iron), vitamins C, PP, E, K, routine, carotene.

a ***b***

Figure 2*: Rhubarb leaves and petioles [5], [3]*

The rhubarb prefers a cooler climate, but also bears warm weather in the southern areas. Taking it from the area of origin is followed by a reduction of active principles content in rhizome and root. For germination it requires moderate temperatures, the high ones that are contributing to the hurrying of this process. The rhubarb is a cold-resistant plant, well frost-resistant up to -15 degrees. The requirements of the species for humidity are high. They begin during germination; seeds need moisture to trigger the processes that lead to embryo initiation. Cultivating rhubarb in areas where the sum of annual rainfall is below 600-800 mm is followed by lower crop yields. Deficiency of soil and air humidity influences the entire metabolism of the plant and the accumulation of certain components. Thus, dry weather favours the formation of ascorbic acid and carbohydrates in the air; rainy weather contributes to the accumulation of oxalic acid. Light is not an essential factor for plant growth and development, which is vigorous, with strong roots and areas of higher cloudiness. But light plays a special role in formation and accumulation of components on which the quality of the raw material depends. Thus, the formation of flavonoids in the roots, the accumulation of malic and citric acids in the leaves are positively influenced by light. A moderate CO_2 concentration stimulates the accumulation of these acids, but a too bright light and the increase in CO_2 at a concentration of 6%, inhibits the biosynthesis of these acids.

It prefers fertile, deep soils with a good structure, rich in calcium. Avoid heavy soils with high acidity that retains water [1]. Ground preparation is done by a deep turning the soil, basic fertilization with manure, and adequate land-modelling of planting requirements and subsequent irrigation [3].

MATERIAL AND METHODS

The plant can be multiplied by seeds or by dividing the bush. Seeds for seedling (Figure 3) are prepared in advance, then resemble in rows at a distance of 25-30 cm. The seed germination temperature is 20 degrees C. In case of seed propagation, rhubarb must be planted in March or the last month of the autumn, reaching maturity only after two years.

Figure 3*: Rhubarb seedling*

To multiply the rhubarb by dividing the bushes, choose plants of 3-4 years get out of the soil and cut into 6-8 pieces, leaving each piece of 1-2 growing buds. Adaptation of the plant for vegetative propagation through rhizomes (fig. 3) is used in practice, with benefits regarding the maintenance of the varieties in the stable form.

Figure 3*: Rhubarb rhizomes*

The rhizomes are planted in well-watered nests, at the same distance as seedling. The leaves are harvested in the second year of planting rhizomes when the petioles reach the length of 20-30 cm and the thickness of 1.5-2 cm.

Planting is done in autumn by preparing rhizomes (fragments with 1-2 buds) on the edges of the open furrow at 1-1.2 m between the rows, which covers the ground to a depth of 0.5 cm above the rhizome.

In the first year of planting and in the following years, maintenance works are being carried out to prevent cropping, fertilization and irrigation. In culture conditions harvesting can be done from the third year. Typically, harvesting takes place in 4-5 years, depending on the size of the roots. Research shows that in the summer months the content in active principles is lower, with sensible increases during autumn and winter. The rhubarb is harvested in autumn in October. The harvesting work begins with the root dislocation being carried out with the beet dilator (fig. 4).

Figure 4:Beet dilator **[7]**

Once they have gathered in the piles by hands, the rhizomes and roots are shaken by the earth, cleansed by stalk debris, broken portions, by removing the leaves and transporting them to the place of conditioning.

In order to process the raw material, the roots must be unloaded before drying. Removal of the superficial tissue of the roots contributes to the enrichment of the final product in active principles, the shell being free of oximetilantraquinones. Roots drying can be done in the sun or in the shade or in the storehouses bridges, dry, well-ventilated rooms, but in autumn, the temperature is lower and higher air humidity, the drying process lasts longer, there is the danger that some of the roots to mould. It is therefore preferable to use the hot air in the driers. The optimum drying temperature is 50-60 °C and after drying the roots get a yellow-brown colour. From 3.5 to 4 kg of fresh roots, 1 kg of dried roots results [1]. Dried roots are packaged in bags and sent to places of exploitation and to traditional and industrial processing.

RESULTS

The red rhubarb stems contain more vitamin A than green ones. Vitamin A is a powerful antioxidant that ensures skin and cell health, provides intracellular immune functions, supports bone metabolism and in the case of pregnant women, helps embryonic development of the fetus within the first few weeks of conception.

The rhubarb is rich in vitamin C, a powerful antioxidant and anti-inflammatory agent that strengthens the immune system, protects it from the toxic effects of external intruders, and also helps to develop healthy and powerful cells in the body. Vitamin C, along with calcium, makes rhubarb a favourite food for strengthening the bone and teeth. Because the rhubarb has a low content of saturated fat and salt, its consumption can help the body to remove the effects of bad cholesterol, and it can also be beneficial for slimming because it increases the level of fat burning in the body. The main nutritional values for 100 g of raw rhubarb are presented in table no. 1 [6]:

Table 1 [6]

Characteristics	**Values**
Minerals:	
calcium (Ca)	86 mg
magnezium (Mg)	12 mg
Pphosphorus	14 mg
potassium	288 mg
salt	4 mg
zinc, selenium, iron	
omega- 6 acids:	**99 mg**
vitamins: A, C, E, folates, choline	**8 mg**
carbohydrates	**4,5 g**
dietary fiber	1,8g
sugars	1,1g

As can be seen in table no. 1, mineral substances are presented in large amounts especially calcium oxalate.
The active principles of the raw material are anthracene derivatives that give it purgative action. These derivatives are found in plants in oxidized form: free anthraquinones and glycosidates, as well as in reduced form: anthranols and anthrone (monomers and dimers = diantrone).

Free anthraquinone compounds are found in small amounts in the roots (0.10-0.40%). Anthraquinone is mainly in glycosidic form. Anthronic and anthranolic glycosides are present in the proportion of 40-60% of the total anthracene derivatives and especially in dimeric form as diantrone in fresh plant. In the drying process, in the presence of enzymes, some of these compounds are oxidized. The superficial tissues of the root are poor in anthracenic derivatives; therefore, by peeling the organ, the content of the derivatives increases.

A second group of active principles are tanoids, which give the plant matter the astringent action.
The rhubarb has astringent, laxative and purgative action, depending on the administered doses. Thus, in small doses it has apoptotic tonic action due to tanoidic derivatives, in medium doses the action is laxative and in high doses the action is purgative. Both actions are due to anthracenozide [1].

The active principles of this plant (extracted from rhizomes and roots) can be used as syrup infusion, decoction and tincture, from which various pharmaceutical specialties are prepared.

CONCLUSIONS

The rhubarb is one of the oldest medicinal herbs known for its purgative, laxative and tonic properties.

The active principles of this plant (rhizome and roots) contain anthraquinones, anthraquinone derivatives, tannins from the group of reotanoids (glucagaline, catechin, epicatehin), organic acids, volatile oil, resins, raponticine, mineral substances. The rhubarb has astringent, laxative and purgative action, depending on the administered doses. Thus, in small doses it has apoptotic tonic action due to tanoidic derivatives, in medium doses the action is laxative and in high doses the action is purgative. Both actions are due to anthracenozide.

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CONSIDERATIONS REGARDING TO BIOLOGICAL TREATMENT METHODS OF WASTE

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REZUMAT

În articol se prezintă aspecte referitoare la principalele metode de tratare a deşeurilor biologice. Lucrarea conţine detalii legate de valorificarea şi reciclarea deşeurilor utilizând procesul de tratare prin compostare cât şi prin fermentare anaerobă, în cadrul sistemelor şi tehnologiilor actuale ce au la baza staţii specializate pentru o utilizare sigură în agricultură. De asemenea, sunt prezentate aspecte cu privire la parametri de bază care influenţează procesul de fermentare a biomasei în vederea obţinerii biogazului.

ABSTRACT

Within the paper are presented aspects regarding to the main methods of treatment for biological waste. The paper contains details regarding to waste capitalization and recycling, using treating process both by composting and anaerobic fermentation within current systems and technologies which are based on specialised stations for a certain using in agriculture. Also, there are presented aspects regarding to the main parameters which influence biomass fermentation process in order to obtain biogas.

KEYWORDS: biogas, composting, waste, anaerobic fermentation, methods, environmental protection

CUVINTE CHEIE: biogaz, compostare, deşeuri, fermentarea anaerobă, metode, protecţia mediului

1. INTRODUCTION

Different causes of pollution have determined, in the last decades, that „environment protection” to become one of the most important and serious humanity issue, which affect human life and economical of the whole world countries; environment protection serves to quantitative and qualitative maintenance of life on Terra. Thus, environmental protection may be defined as a conscious human activity, scientifically substantiated, targeted to maintaining and improving the life conditions, aiming at achieving a certain and specific target, consisting in preventing the pollution, maintaining and improving life conditions on earth [12].

As renewable energy source and recyclable materials, biological waste represents a considerable potential. The waste biological treatment represent the totality of treatment procedures by which organic and inorganic materials are decomposed by the help of bacteria or/and enzymes in aerobic and anaerobic conditions.

Process setting is achieved by: presence or absence of oxygen, assuring an optimal temperature, continuous setting of humidity [4].

The greatest threat to environment caused by biological waste is methane producing, a gas with greenhouse effect, of 25 times in power than dioxide carbon. If waste biological treatment should be maximised, the most palpable and important achievement is prevention of greenhouse effect-estimated at approximately at 10 mil. tonnes of CO2 equivalent in 2020.

By using biogas based on biological waste could be fulfilled nearly a third of the EU's 2020 target for renewable energy in transport, and by converting all biological waste could be fulfilled about 2% of the overall EU renewable energy objective.

Economical and environmental advantages of different biological treatment methods depend of existent circumstances at local level, such as population density, climate and infrastructure [9].

According to International Agency for Energy, a number of several thousands of agricultural factories which use anaerobe digestion process are functionally in Europe and North America. Many of them are represented of advanced installations from technological point of view, builder at large scale, and their number considerably increasing in the last years. It is estimated that at European level is a considerable potential for increasing the current production of biogas, on the base of activities from livestock domain. After enlargement of EU, the new countries members of the East Europe also have to use these technologies and to benefit of their high potential for biogas. Implementing the technologies regarding to anaerobic digestion process in these countries, will contribute to reduction a high number of issues of environmental pollution, with intensifying sustainable development of rural community and of agricultural sector, in general [11].

Waste capitalization represent only the second from the best two solutions of waste management, because by collecting and treatment of waste components which can be capitalized, can be accomplished an energy and resources consume enough high. Since in material structure of these waste there are found significant differences, procedures and techniques have to be adapted to each waste.

Biomass decomposing of vegetable or animal origin is accomplished in nature by unicellular organisms (microorganisms), without to be necessary an energetic contribution. Choosing a capitalization method always means to adopt an ecological manner one.

MATERIAL AND METHODS

The main biological treatment methods of waste are: composting and digestion (anaerobe fermentation). Composting and anaerobic digestion offer the most promising economic and environmental options in case of biological waste, whose generation cannot be prevent. Nevertheless, development of these processes on the base of a quality input represents a previous condition. In most of the cases this objective can be best achieved by separate collecting method of biological waste [9].

Composting is an ecologic method of agricultural waste processing, agro-food or household, by their changing in an unpolluted product, named compost, with high nutritive value for plants and cereals, respective a very good fertilizer of physical and chemical status of soils. In figure 1 are illustrated stations and machinery for compost. [4]

Appropriate for composting treatment process are the following waste types:

- ✓ biologic household waste (kitchen waste from preparing food, vegetable parts, food remains);
- ✓ garden and parks waste (vegetable waste, ornamental plants, cuts of trees and shrubs, grass and leaves);
- ✓ mud from wastewater treatment plant (in small percentage of mass);
- ✓ agricultural waste;
- ✓ forestry waste in special cases (tree bark, chopped straw).

Figure 1: *Stations and machinery for compost (Hejöpapi - Ungaria) [4]*

Responsible of biologic treatment process by composting is microbial biomass (= microbes mass) whose development is dependent of:

- ✓ temperature (increasing speed of methane bacteria, so, yield in biogas has optimal values between 6 and 55 ^{0}C);
- ✓ available in oxygen;
- ✓ chemical structure and material composition;
- ✓ pH value.

Optimum interval of pH for aerobic fermentation in mesophilic temperature is situated between 6,5 and 8. Ph value may be increased by ammonia during decomposing the proteins or by its presence in food flow, while volatile fatty acid accumulation decreases the pH value [1].

For optimal increase of biomass, have to be available in an appropriate ratio with: carbon, nitrogen, nutritive base substances, traces of nutritive substances and all other necessary active elements.

For assuring the base conditions at microbial transforming of substances, have to be controlled and eventually, set the ratio C : N, all other substances being present in different quantities in fermentation process.

Ratio C/N of substrate or mix of substrates, used in anaerobic fermentation process influence substantially biogas production [6].

For an adequate going on of the anaerobic fermentation process, the value of the C/N ratio, have to be between 20 and 30 [3].

Composting stations split in several functioning, namely: pre-treatment, fermentation, compost preparing and storing.

On treated surfaces, storing and preparing from composting stations is achieved residual water. These surfaces have to be isolated according to water and building legislation (for e.g. through layers of asphalt). Collected water has to be conducted and removed, so that, subsoil and surrounding areas not to be polluted. Roofs on these surfaces are considerably diminished by polluted water quantity.

A feeding water network with receiving points (hydrants) in whole sector of installations is appropriate.

For composting optimization process and simultaneous minimizing the gaseous emissions (especially odours), receiving, biological treatment and preparing, have to be achieved in closed system.

If waste treatment is achieved in closed halls, it must be especially in view the conditions for personnel. Pollutions because of high concentrations of microorganisms (for e.g. fungal spores), odour and dangerous gasses have to be avoided.

Beside gaseous emissions, there are accomplished at biological treatment of waste, the following rests:

- ✓ rests from gathering;
- ✓ rests from sieving;
- ✓ seepage water from composting;
- ✓ remnants from water seepage sedimentation of composting;
- ✓ rainwater washes.

The residues coming from infiltration water sedimentation from composting may be introduced in composting process. Waters have to be used especially at material wetting. Other remains, as much as possible, have to be exploited.

The existing composting methods used nowadays in Central Europe [3] mainly differ through:

- ✓ overturning technique for compost material;
- ✓ carrying out biological process;
- ✓ ventilation technique for the fermentation process;
- ✓ process duration during intensive fermentation;
- ✓ maturation degree of the final material.

Types of methods and techniques of composting:[4]

- ✓ piles composting (opened or encapsulated) ;
- ✓ tunnel composting or lines;
- ✓ composting in boxes;
- ✓ containers composting;
- ✓ composting in drum;
- ✓ composting in ricochet.

Open piles composting without forced ventilation is the applicable method with the lowest technical effort. Fermentation duration is of about 3 to 6 month, in function of overturning frequency. In figure 2 is presented an overturning apparatus for piles from open composting.

Figure 2: *Overturning apparatus for piles from open composting*

At composting in tunnel (fig. 3) the lines are covered up and thus “encapsulated” regarding to emissions spreading. Residual air flowing is thus optimised. After 1 to 3 months, could be obtained composts until IV degree.

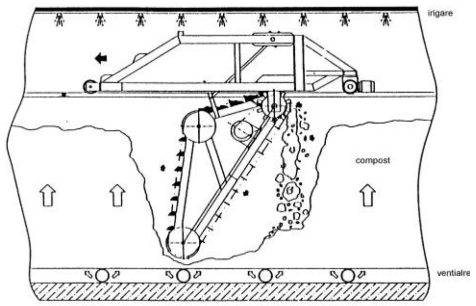

Figure 3: *Composting in Bioferm tunnel. Mixture and transport apparatus [8]*

*Composting in boxe*s represents a variant of intensive fermentation, out of which is obtaining green compost, of I and II degrees. After this intensive fermentation is usually achieved the preparing forwards the compost until la III, IV or V in post fermentation. This is performing by composting with trapezoid or flat piles.

In contrast with composting in boxes, at *composting in containers* the intensive fermentation is achieved, not in fix reactors, but in mobile containers, with a volume of approximately 22 m^3. The other processes components are similar.

Composting in drum is a typically pre f*ermentation - method before ferm*entation itself, in plane or trapezoidal piles. Method conducts to an appropriate grounding and mixing of material and that is why is widespread to residual waste penetration and of garbage as a whole.

Composting in ricochet essentially differs of all composting methods because the material destined to fermentation is not treated as pile form or bulk material, but pressed biological waste are subject to a strong decompose by fungi.

Anaerobic fermentation is the method of biological treatment which can be used for recovery both fertilizer element and energy, contained in biodegradable waste, representing the conducted process of discomposing of wet organic material, which carries on closed precinct, in controlled environment conditions, in absence of molecular oxygen and light, and in presence of many bacteria species [2].

As a consequence of anaerobic digestion of waste result two main products:

- Biogas – alternative energy source;
- Sludge- soil amendment or fertiliser.

At first glance, anaerobic digestion is the ideal solution for organic waste, because all final products may be capitalised. In reality, this technology is very difficult to be applied, because is influenced by a great number of parameters which are difficult to control. The biggest impediment is represented by anaerobic conditions fulfilment and the temperatures necessary for process.

RESULTS

The main elements of carrying out the processes in installations of composting are presented in fig. 4. Composting procedures offered by market differ especially by fermentation system. Lately, there is intensive fermentation, from occurring considerable differences of methodological technique for decomposing processes controlling.

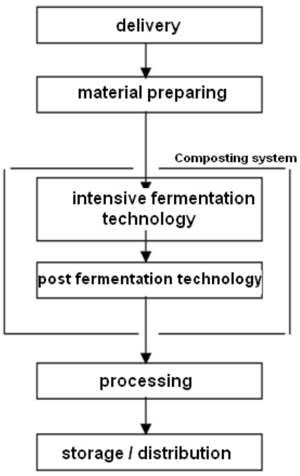

Figure 4: *The base of a composting installation*

Composting process control is based on homogenization and mixing the waste, followed by aeration and irrigation. This conduct to achieving a dark colour stabilised material, rich in humic substances and fertilizers. In figure 5 is presented schematic diagram of the composting process:

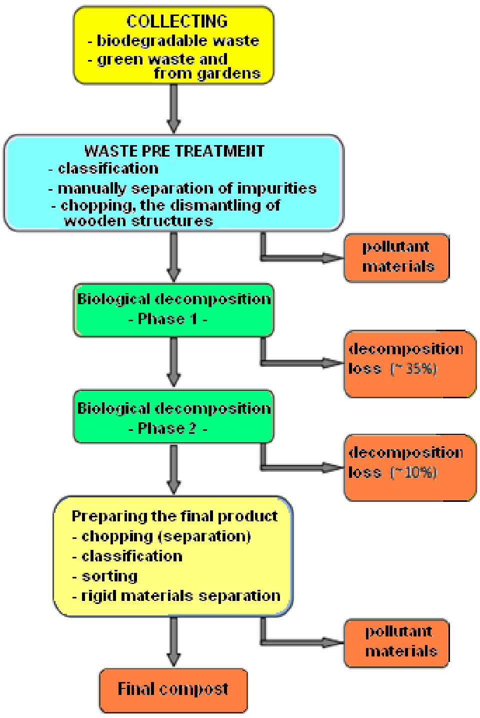

Figure 5: *Basic schematic diagram of the composting process [4]*

The centralised composting stations can treat more than 100.000 tones/year of biodegradable waste, but typically dimension of a composting station is of 10,000 to 30,000 Tonnes/year.

Basic scheme of anaerobic fermentation is presented in fig. 6:

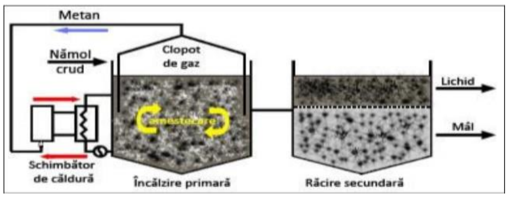

Figure 6: *Basic scheme of anaerobic fermentation [4]*

At the present, the most important application of anaerobic digestion processes are represented by biogas performing in special installations (fig. 7), by processing the substrates coming from agriculture.

Figure 7: *Biogas installation [7]*

Biogas is a mixing of combustible gases, which are forming by decomposition of organic substances in wet environment and lack of oxygen. Biogas composition is presented in table no 1:

Table 1

Materie	Vol. %
Methan (CH_4)	40-79
Carbon dioxide (CO_2)	25-60
Nitrogen bioxide (NO_2)	0-7
Oxiygen (O_2)	0-2
Hydrogen (H_2)	0-1
Hydrogen sulfide (H_2S)	0-1

From table no. 1 it is noticed that the main component of biogas is represented by methane contains. In table no. 2, 3 and 4 are presented energy values for 1 m^3 of biogas [10].

Table 2

Methane %	kcal/m^3	
	la 0^0 C	la 20^0 C
50	4275	3962
51	4360	4040
52	4446	4120
53	4531	4199
54	4617	4278
55	4702	4357
56	4788	4437
57	4873	4516
58	4959	4596
59	5044	4674

Table 3

Methane %	kcal/m^3	
	la 0^0 C	la 20^0 C
60	5130	4754
61	5215	4833
62	5301	4912
63	5386	4991
64	5472	5071
65	5557	5150
66	5643	5230
67	5728	5308
68	5814	5388
69	5900	5468

Table 4

Methane %	kcal/m^3	
	la 0^0 C	la 20^0 C
70	5985	5546
71	6070	5625
72	6156	5705
73	6241	5784
74	6327	5863
75	6412	5942
76	6498	6022
77	6583	6101
78	6669	6180
79	6754	6259

CONCLUSIONS

Composting belongs to classical waste treatment procedures, being an ecologic treatment method, useful because waste biodegradable part represents about 50% out of the total household waste. Comparing to other waste treatment methods, composting requires a low load to the environment.

C/N Ratio value of the mix is subject to the anaerobic fermentation process is recommended to be between 20 and 30;

Increasing speed of methane bacteria, so, biogas yield, has optimum values between the limits of 6 to 55 ^{0}C, and in optimum pH interval for anaerobic fermentation in mesophilic temperature is placed between 6,5 and 8.

It is noticed that biogas is a valuable fuel and biogas stations are a supplementary chance for agricultural field, appearing as a supplementary considerable income source.

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