

IMPORTANCE OF OCCUPATIONAL HEALTH AND SAFETY IN BIOTECHNOLOGICAL PROCESSES

Luma Mirely de Souza Brandão^a, Milson dos Santos Barbosa^a, Isabela Nascimento Souza^a, Lays Carvalho de Almeida^a, Danyelle Andrade Mota^a

^a Universidade Tiradentes, Brazil

Abstract: A great option to change partially or completely conventional chemical processes is biotechnological processes. However, the security of these processes has not been fully examined. Thus, this work aims to elucidate the importance of assessing and controlling potential risks, in order to develop bioprocesses in a safer way. For this, a qualitative research was carried out through scientific studies and current legislation. Dangers of biotechnological processes require planning and development of safe bioprocesses, with high security for all employees involved. It is perceived that the possible harmful impacts that can reach workers are the central part of this concern, since these employers may be directly exposed to risks and dangers.

Keywords: Bioprocesses; Occupational safety; Occupational health; Ricks.

IMPORTÂNCIA DA SAÚDE E SEGURANÇA DO TRABALHO NOS PROCESSOS BIOTECNOLÓGICOS

Resumo: Uma ótima opção para trocar de forma parcial ou total os processos químicos convencionais são os processos biotecnológicos. No entanto, a segurança desses processos não foi inteiramente examinada. Assim, este trabalho tem como objetivo elucidar a importância de avaliar e controlar os riscos potenciais, com o intuito de desenvolver bioprocessos de forma mais segura. Para isso, foi realizada uma pesquisa qualitativa por meio de estudos científicos e legislação vigente. Os perigos dos processos biotecnológicos requerem um planejamento e desenvolvimento de bioprocessos seguros, com elevada segurança para todos os empregados envolvidos. Percebe-se que os possíveis impactos maléficos que podem atingir os trabalhadores são a parte central dessa preocupação, visto que esses empregadores podem estar diretamente expostos aos riscos e perigos.

Palavras-chave: Bioprocessos; Segurança do trabalho; Saúde do trabalho; Riscos.

1. INTRODUCTION

Processes that involve several stages of transformation through biological agents, such as enzymes, microorganisms or animal and plant cells, are called bioprocesses [1]. Bioprocesses have attracted a lot of attention due to being a sustainable and innovative alternative for industry [2]. Thus, scientific and technological research has sought to develop and transform processes and products by biotechnological processes in order to reduce negative impacts on the environment and use of fossil fuels. In this context, bioprocesses have been used in several applications, such as fuel and pharmaceutical products [3,4].

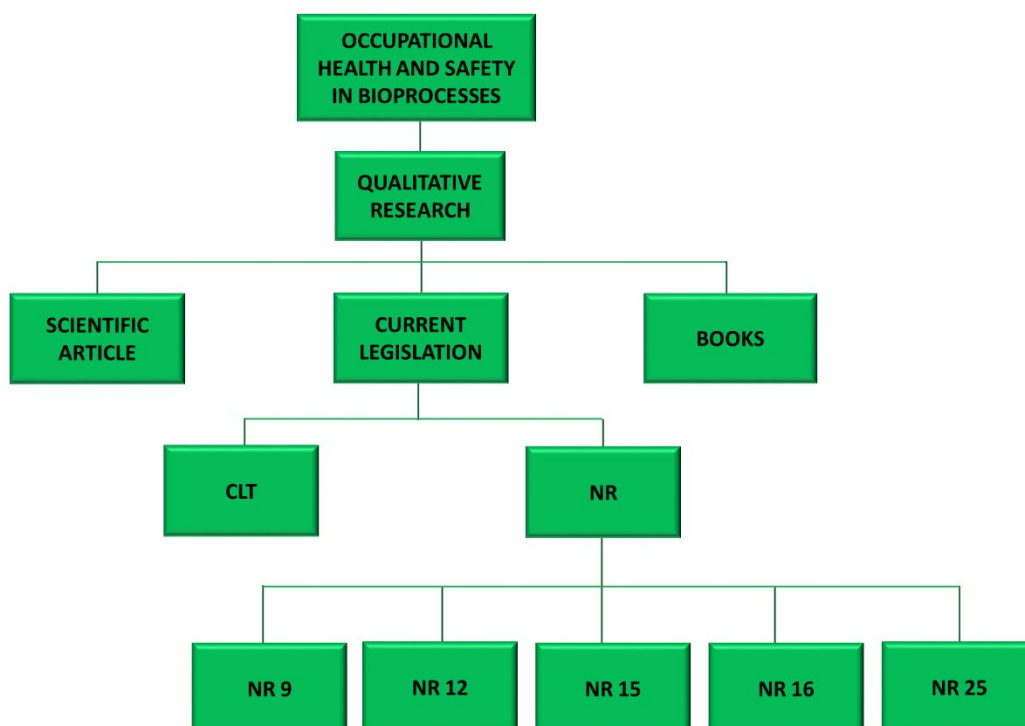
The main operations in bioprocesses include fermentation, microbial and enzymatic catalysis [5]. Bioprocesses are often justified as processes with less environmental impact than conventional chemical technologies. On the other hand, their development of safe way is little discussed. It is important to highlight that many amounts of organic solvents for extraction from aqueous solutions can be used in some bioproduct processing. Therefore, the steps of processing, recycling, control and safe disposal are necessary for both organic solvents and microorganisms. Risks are directly related to the means and conditions in which operations occur [6].

Use of bioprocess technologies in research and industrial development activities has grown in the world. In view of this, there is need for special attention to the hygiene and safety in bioprocesses in order to preserve the health, integrity and safety of workers and environment. Along with the accelerated use of this process, a great problem arises, which is the little knowledge and awareness of risk management systems in order to mitigate the risks from this process [7]. Therefore, this work aims to elucidate the importance of assessing and controlling potential risks, in order to develop bioprocesses of safer way for workers, environment and society.

2. METHODOLOGY

Research on occupational health and safety in bioprocesses was carried out through important national and international bibliographic databases. The information was collected from scientific studies such as articles and books, published in indexed and specialized journals. In addition, Consolidation of Labor Laws (CLT) [8] and Regulatory Norms (NR) [9] were the current legislation used as basis. Among the NR, NR 9 (Environmental Risk Prevention Program), NR 12 (Machines and Equipment), NR 15 (Unhealthy Activities and Operations), NR 16 (Dangerous activities and operations) e NR 25 (Industrial Waste) were used, since these regulatory norms cover activities carried out in biocatalytic processes. Figure 1 shows the flowchart of the methodology performed.

Figure 1. Qualitative research developed in this work.



3. RESULTS AND DISCUSSION

Benefits that the development of bioprocesses of safe way can bring to industries, companies, workers and society are notorious. This safe development promotes the safety of workers throughout the enzymatic and fermentative processes. Among these benefits, the diffusion of bioprocesses is associated with both social and commercial benefits, which include high-paying jobs, use of waste and innovative products that address critical social problems in materials, health, transport, energy and pollution. Moreover, safer processes lead to greater safety for the worker, through sensors that detect dangerous agents, appropriate protective equipment and among others [10].

In order for this safe development to happen, security measures must be taken rigorously. Health risks from exposure to biotechnological processes must be eliminated or reduced, in order that inputs and products based on that process progress and their benefits are used. However, it is contradictory to say that the development of bioprocesses is responsible, if the health and safety of workers are negatively affected, as well as the environment. This understanding corroborates with NR 9 [11], which explains as follows:

Obligation to prepare and implement the Environmental Risk Prevention Program - PPRA by all employers and institutions that hire workers as employees, aimed at preserving the health and integrity of employees through anticipation, recognition, evaluation and control of the environmental risks that exist or will exist in the workplace by taking the protection of the environment and natural resources into consideration [11].

Despite being an arduous task, the safe and responsible development of bioprocesses and any other industrial process depends on the health and safety of workers and the environment, since both are linked. In addition, risks, dangers, exposures, doses, control and possible impacts must be understood by everyone involved, in order to avoid possible accidents that compromise the health and integrity of the worker and the environment. It is also necessary that companies, the government and other organizations invest in compliance with preventive guidance to protect workers. It is important to note that employers must assess all risks inherent in the processes to which workers are exposed, and employers must inform their employees. In this sense, NR 9 establishes that "Employers shall inform workers in an appropriate and sufficient manner of the environmental risks that may arise in the workplace and of the means available to prevent or limit such risks and to protect themselves from said risks [11].

Although the assessment of risk exposures in the workplace is the employer's responsibility, government agencies and other organizations are responsible for continuously analyzing whether the control of workers' exposures to these risks is being carried out properly and without harm to workers and the environment. One of the most critical factors that increases the risk is exposure. Thus, there is a need to identify the agents and determine the exposures to these agents in the work environment, in order to develop risk management appropriately [13]. In this scenario, employers must be aware and assess how the frequency of exposure to risk agents and their magnitude actually occurs. In order to establish properly occupational exposure to bioprocesses, it is necessary to obtain information about the monitoring of risk agents in the work environment. Additionally, this information can be complemented by means of biological monitoring strategies that assess exposure by all routes.

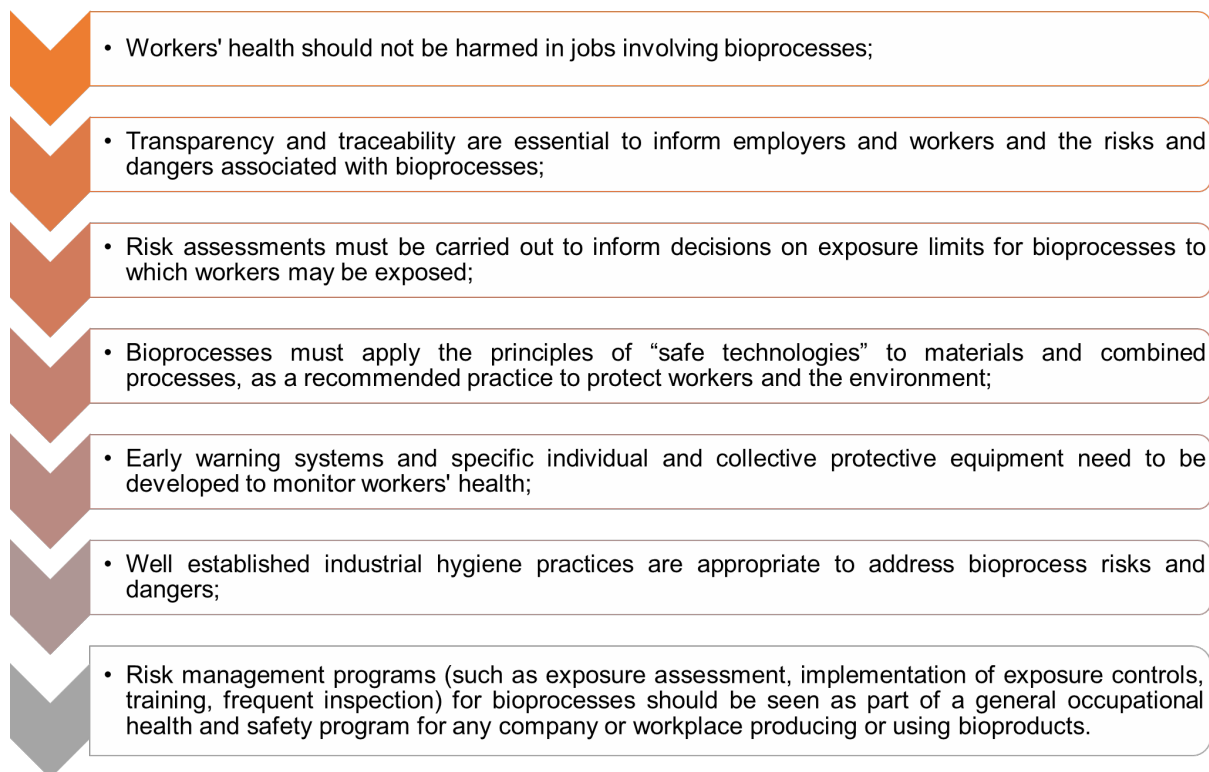
Another factor that is very important in the safe and responsible development of bioprocesses is the exposure assessment. This assessment includes the identification of risks, in terms of actual exposure and the exposure potential with adverse effects. A sampling frame can be made based on the evaluation data in order to build exposure records that can assist future training associated with the processes in a more specific way [13]. In addition, these data can be used in the risk assessment and define of occupational exposure limits. It is important to emphasize that just assessing the risks is not enough, there is a need for communication about risks between employers, government agencies and organizations promoting of occupational safety and health. Thus, the data of exposure to the risks of each biological process, when properly disclosed, assists in the choice of risk management decisions, identifies and recognizes the uncertainties associated with biotechnological processes [14].

In bioprocesses, the complexity of risks inherent to the process is very large, in addition to limited the knowledge related to safety. Today, the authorities have instructed the knowledge of the application of bioprocesses and the control of exposures. It is important to highlight that employers are responsible for risk management. Thus, it is up to the employer to control exposures in the work environment and workers to collaborate with employers in the execution of processes and risk management [15].

The precision of regulation of safe processes related to bioprocesses, which is similar to the regulation of other risks and hazards related to conventional processes, has been reported by many studies [6,16]. Regulatory agencies request the execution of good risk management conducts, although there are some general regulations that

meet the requirements of biological and related processes, with the aim of developing safe and responsible biotechnological processes. In general, the works show global parameters for the safe exercise of bioprocesses, as shown in Figure 2 [5, 6, 17]:

Figure 2. Global parameters for the safe exercise of bioprocesses.



In general, an adequate application of recognized procedures, such as appropriate microbiological techniques, appropriate containment devices, adequate facilities, protective barriers and specialized training of the workers involved, allows the minimization and control of risks related to bioprocesses. Occupational damage can be avoided with adequate knowledge about standardized microbiological procedures and mechanisms and the use of containment devices, facilities and protective barriers. Adverse effects can be prevented or reduced through training and knowledge about epidemiology, pathogenicity, and the biological and chemical risks of microorganisms and organic solvents. Past mistakes can serve as lessons to prevent future problems, which is very advantageous for both scientific and industrial society. Thus, for the development of safer and more responsible biotechnological processes, it is essential that the health and integrity of workers, as well as the environment and society in general, be considered through knowledge and current legislation.

4. CONCLUSION

Bioprocesses are a great option for industrial processes and have already been carried out for large-scale production. Although relevant, the safety of these processes has not been thoroughly studied and examined until now. The risks of these processes include conventional biological and chemical risks related to the existence of microorganisms. It is noticed that the existing procedures for the assessment of risks

related to bioprocesses constitute in phases similar to those commonly used in chemical risk assessments, for example: identification and characterization of biological risks; estimation of exposure and its consequences; and risk mitigation. This phase of identifying of risks in bioprocesses plays a critical role, since all risks not detected lead to unmanaged and thus uncontrolled risks. Thus, it is essential to identify the specific risks of industrial bioprocesses to guarantee their expansion and develop safe procedures. Despite the fact that bioprocesses are normally repaired as safe technologies, having less impact than conventional chemical processes, current accidents have affected this industrial sector. These accidents can be seen as early warnings of an emerging point and, since then, the safe development of bioprocesses as a new option or as a complement to the existing methods of chemical production is a reality that is growing more and more.

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