Part 2. Biosafety

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THE EFFECTIVENESS OF APPLICATION ULTRAVIOLET RADIATION FOR THE SANITATION OF PRODUCTION PREMISES OF MEAT PROCESSING ENTERPRISES

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Summary. Bacteriological researches are found ongoing increase of a total number of microorganisms (TNM) in premises during the working day. Air disinfection in premises amounted 98–100% after use of UV radiation. Use of arrangement of closed type (recirculators) allowed reducing TNM in air of working premises on 25.3 %. It is proposed solution of technology of air disinfection in production premises of meat processing enterprises with the help of UVR–recirculators.

Keywords: disinfection, sanitation, ultraviolet, germicidal lamp, UVR recyclers

Introduction. Great attention in the world-wide practice is paid to the problem of obtaining product of high sanitary quality and safety for human at the enterprise of meat and meat products (Bawcom et al., 1995; Castillo et al., 1998; Bolder, 1997).

Large number of microorganisms, including pathogenic — *Escherichia coli* (*E. coli*), *Staphylococcus*, fungi etc., accumulate in the air of meat-shops and meat-processing plants while the slaughter of cattle and meat processing. Microorganisms that are accumulated in the air, on the walls and process equipment, regardless of pathogenicity and their metabolic products (especially microscopic fungi) in case of contact with raw meat may generate a risk to human health due to contamination or food poisoning. Therefore, to obtain safe products of high sanitary quality for human is need to use ecologically safe methods of sanitation of the ambient air in premises of meat enterprise shops (Bohatko and Sakhniuk, 2013; Prokopenko, 2013).

With the aim of disinfection of objects veterinary supervision were developed, tested and proposed for use a wide range of efficient disinfectants and detergent–disinfectants, use of which allows to maintain the veterinary-sanitary status of the processed objects at a high level. However, most of the existing specimens in their physico-chemical and toxicology characteristics do not match any existing today the requirements, especially when they are used in the food industry. Therefore, it is a reasoned necessary search of ecologically safe and highly effective methods of sanitation (Paliy and Paliy, 2016).

Today, ultraviolet germicidal radiation (UV radiation) is one of the most effective preventive sanitary-hygienic means, which suppress the viability of microorganisms in air and water. UVR is widely used abroad as well as in Ukraine at food industry enterprises (shop meat, fish, dairy, bakery, brewery, fruits and vegetables and other products, food bases, warehouses, stores, etc.) for disinfection of air and process equipment surfaces with the aim to compliance the hygienic requirements to the indicator standards of the quality and safety of food raw materials and food products. But the main use of UV in the food industry is disinfection of air in the production area to prevent contamination of the production by airborne organisms (Illarionova, Gymerov and Reshetnik, 2010; Prokopenko, 2013).

UV disinfection has certain advantages in comparing with traditional thermal and chemical disinfectants. So, its bactericidal action more effective at room-temperature, there is no impact on objects, which are processed, satisfy the requirements of environmental safety, has greater producing capacity at a lower laboriousness of the operations for machining, does not require special protective measures, is economically advantageous, and its use eliminates the necessity of usage large quantities of disinfectants (Ivanenko, Khizgiyaev and Mizgaylov, 2006; Tiganov, 2007).

The rational use of UV radiation does not negatively affect the organoleptic (color, smell, taste, texture, appearance) and physicochemical features of foods and raw materials of animal origin (Tiganov, 2007).

The aim of this work was to study the efficiency of disinfection of air in premises of meat enterprise shops of meat processing enterprises with the use of germicidal lamps and UV emitters-recirculators.

Materials and methods. Experimental researches were carried out at Luhansk Meat Packing Plant, PUBJSC according to the current regulatory documents to standard procedures (Antonov and Blinov, 1971).

Sanitary-microbiological parameters of air were studied in the premises of the meat processing enterprises using UV emitters-recyclers (one recirculator per 100 m^3) and the germicidal lamps DB-30-1 that are in block system made of two units. Each lamp power is 30 W, bactericidal flux of 6 W. The average action term of the tested lamps is required current regulatory documents and does not transcend the 5000 hours.

Air samples were taken before process, in 3, 6, and 9 hours and at the end of a shift after carrying out preventive disinfection.

Sanitary-bacteriological studies of the air were studied by sampling the air sedimentation plating technique using meat-peptone agar (MPA) and Sabouraud medium according to the general adopted methodology. Plating was incubated in a thermostat at 37 °C for 2–5 days. Quantity was carried out by the method of counting colony in air per 1 m^3 (Antonov and Blinov, 1971).

Results. Three experiments were carried out to study the sanitary-microbiological background of air at meat enterprise shops of meat processing enterprises.

At the first experiment it was studied sanitary-microbiological air composition in condition of using germicidal lamps DB-30-1 that are in block system made of two units. The results are presented in Table 1.

Table 1 – The efficiency of use of germicidal lamps for air disinfection departments of meat processing enterprises

Research zone	Quantity of microorganisms in the air, ths/m^3		Efficiency of disinfection, %
	before start working germicidal lamps	after using UVR	
Meat-fatty shop			
Cattle and horse processing line	9.1×10^{-3}	1.8×10^{-2}	98
Pig processing line	9.3×10^{-3}	1.9×10^{-2}	98
Preparation of the intestinal sheath line	13.2×10^{-3}	4.0×10^{-2}	97
Shop deboning and trimming of raw meat			
Cattle and horse processing line	5.4×10^{-3}	0	100
Pig processing line	5.5×10^{-3}	0	100
Semi-finished shop			
Central hall	7.2×10^{-3}	4.1×10^{-2}	94.3
Storage of finished products	7.4×10^{-3}	3.4×10^{-2}	95.4
Meat expedition	7.5×10^{3}	3.4×10^{-2}	95.4
Sausage shop			
Vacuum pack department (Cryovac® line)	2.8×10^{-3}	0	100
Vacuum pack department (line Multivac)	2.3×10^{-3}	0	100
Sausage expedition	2.8×10^{-3}	0	100

According to the research results, given in Table 1, it was established that the efficiency of use of UVR is 98% after carrying out preventive disinfecting at the end of the work shift for 1 hour and 30 minutes before the start of process. The disinfection efficiency of 100 % was achieved in the experimental premises of the sausage shop and shop deboning and trimming raw meat.

To our mind the reason for reducing the effectiveness of air disinfection UVR in the meat-fat workshop and the semi-finished products workshop was high humidity 76±2%, that is why the result of transmittance radiation energy is reduced. In addition, the reason might be the lack of control the germicidal lamps.

While setting the second experiment it was studied the changes in sanitary-microbiological composition of the air premises of the meat processing enterprises during working time. Samples were taken in 3, 6 and 9 hours after starting process. Sanitation of air was conducted by UV radiation for 1 hour before starting the experiment. The results of the experiment are shown in Table 2.

Table 2 – The results of sanitary-microbiological control of the indoor air in meat processing plants during the working time

Research zone	Quantity of microorganisms in the air					
	TNM, ths/m³			Fungi and yeast, CFU		
	In/h 3 h	In/h 6 h	In/h 9 h	In/h 3 h	In/h 6 h	In/h 9 h
Meat-fatty shop						
Cattle and horse processing line	5.2×10^{-3}	7.1×10^{-3}	9.3×10^{-3}	5.0×10^{-1}	6.0×10^{-1}	8.0×10^{-1}
Pig processing line	5.3×10^{-3}	8.3×10^{-3}	1.0×10^{-4}	5.0×10^{-1}	7.0×10^{-1}	9.0×10^{-1}
Preparation of the intestinal sheath line	5.4×10^{-3}	1.0×10^{-4}	1.3×10^{-4}	6.0×10^{-1}	10.0×10^{-1}	11.0×10^{-1}
Preparation of the intestinal sheath line						
Poultry processing line	3.1×10^{-3}	4.5×10^{-3}	5.7×10^{-3}	3.0×10^{-1}	5.0×10^{-1}	6.0×10^{-1}
Main process line	3.0×10^{-3}	4.5×10^{-3}	5.5×10^{-3}	3.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Semi-finished shop						
Central hall	5.6×10^{-3}	6.3×10^{-3}	6.9×10^{-3}	3.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Storage of finished products	4.3×10^{-3}	6.2×10^{-3}	7.1×10^{-3}	3.0×10^{-1}	4.0×10^{-1}	5.0×10^{-1}
Meat expedition	5.6×10^{-3}	6.8×10^{-3}	7.4×10^{3}	4.0×10^{-1}	5.0×10^{-1}	7.0×10^{-1}
Sausage shop						
Vacuum pack department (Cryovac® line)	1.6×10^{-3}	2.1×10^{-3}	2.6×10^{-3}	1.0×10^{-1}	2.0×10^{-1}	2.0×10^{-1}
Vacuum pack department (line Multivac)	1.5×10^{-3}	2.0×10^{-3}	2.3×10^{-3}	1.0×10^{-1}	2.0×10^{-1}	2.0×10^{-1}
Sausage expedition	2.1×10^{-3}	2.3×10^{-3}	2.8×10^{-3}	2.0×10^{-1}	3.0×10^{-1}	3.0×10^{-1}

According to the readings given in Table 2 we see that in 3 hours after the start of process the air contamination in industrial premises is in average of $3.9\pm0.15\times10^{-3}$ ths/m³. The number of fungi and yeast is increased almost in 3.3 times. The largest air contamination has a meat-fatty shop; it is $5.2\pm0.1\times10^{-3}$ ths/m³, which is three times more than at the beginning of the experiment. In 6 hours after start process in the workshops of meat-processing enterprises the number of microorganisms in the air grew more in 1.5 times, while the number of fungi and yeast — in 4.9 times. After 9 hours, i.e. at the end of the work shift, the average total number of microorganisms in air is 6.6×10^{-3} ths/m³, and the number of fungi and yeasts reached the level of 5,5±0,5 CFU/m³.

At the third experiment it was studied the sanitary and microbiological indicators of the air in the workshops of meat-processing enterprises in condition of use of UVR-recirculator of closed type when one recirculator is installed at the rate per 100 m³ and additional work of germicidal lamps while 30 minutes before work and then after cleaning the shop at the end of the shift.

Disinfection by UV recirculator was performed continuously during the work shift. Air samples were taken before starting work in the shop and in 3, 6 and 9 hours after turning on recirculator in condition the additional use of germicidal lamps before working in the shops, and after carrying out preventive disinfecting at the end of the work shift. The results are presented in Table 3.

Table 3 – The results of sanitary-microbiological air control of and meat-processing plants in using UVR-recirculators

Research zone	Quantity of microorganisms in the air, ths/m³					
	TNM			Fungi and yeast		
	In/h 3 h	In/h 6 h	In/h 9 h	In/h 3 h	In/h 6 h	In/h 9 h
Meat-fatty shop						
Cattle and horse processing line	5.1×10^{-3}	5.7×10^{-3}	5.9×10^{-3}	5.0×10^{-1}	6.0×10^{-1}	6.0×10^{-1}
Pig processing line	5.2×10^{-3}	5.6×10^{-3}	5.7×10^{-3}	5.0×10^{-1}	7.0×10^{-1}	8.0×10^{-1}
Preparation of the intestinal sheath line	5.4×10^{-3}	6.3×10^{-3}	6.5×10^{-3}	6.0×10^{-1}	7.0×10^{-1}	8.0×10^{-1}
Preparation of the intestinal sheath line						
Cattle and horse processing line	3.1×10^{-3}	3.5×10^{-3}	3.7×10^{-3}	3.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Pig processing line	3.0×10^{-3}	3.5×10^{-3}	3.6×10^{-3}	3.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Semi-finished Shop						
Central hall	5.5×10^{-3}	5.9×10^{-3}	6.0×10^{-3}	4.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Storage of finished products	4.3×10^{-3}	5.2×10^{-3}	5.7×10^{-3}	4.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Meat expedition	5.7×10^{-3}	6.0×10^{-3}	6.2×10^{-3}	5.0×10^{-1}	5.0×10^{-1}	5.0×10^{-1}
Sausage shop						
Vacuum pack department (Cryovac® line)	1.6×10^{-3}	1.7×10^{-3}	1.8×10^{-3}	2.0×10^{-1}	2.0×10^{-1}	2.0×10^{-1}
Vacuum pack department (line Multivac)	1.5×10^{-3}	1.8×10^{-3}	1.8×10^{-3}	2.0×10^{-1}	2.0×10^{-1}	2.0×10^{-1}
Sausage expedition	2.1×10^{-3}	2.3×10^{-3}	2.4×10^{-3}	2.0×10^{-1}	3.0×10^{-1}	3.0×10^{-1}

According to the readings given in Table 3 we see that in 3 hours after the start processing the air contamination of industrial premises is an average $4.25\pm0.15\times10^{-3}$ ths/m³. The number of fungi and yeast was increased almost in 3.3 times. The biggest air contamination was in meat-fatty shop, which was $5.23\pm0.1\times10^{-3}$ ths/m³. In 6 hours after starting work in the shops of meat processing enterprises the number of microorganisms in the air was $4.32\pm0.2\times10^{-3}$ ths/m³, which is on 23% less compared with the second experiment. The number of fungi and yeast increased in 4.7 times, it is on 5% less compared with the second experiment. In 9 hours, i.e. at the end of the work shift, the average total number of microorganisms in the air was $4.9\pm0.15\times10^{-3}$ ths/m³, which is on 25.3% more efficient compared to use only the germicidal lamps. The number of fungi and yeast in 9 hours reached the level 5.1±0.2CFU/m³, which is on 7.3% less compared with the second experiment.

Conclusions. The effectiveness of air disinfection in departments of meat processing enterprises while the use of germicidal lamps DB-30-1 after carrying out preventive disinfection reached 99±1%.

It is investigated that the total number of microorganisms, fungi and yeast in the air while work time at meat processing enterprise increase almost in 3.3 times that does not ensure the stability of microbiological indicators of the air in the production areas and therefore cannot guarantee the quality and safety of sausages and meat semi-finished products in violation of veterinary and sanitary operation mode.

The use of UV-recirculator during the working hours allows maintain the hygienic condition of air while working hours and reduces bacterial air contamination in the industrial premises on 25.3% and on 7.3% in fungi and yeast. The outlook of further studies is using the results to improve the modern system of sanitary-microbiological control at meat processing enterprises in Ukraine.

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