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Short communication

Influence of punch diameter change on the quality attributes of tablets

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Introduction

Tablets are the most widely used pharmaceutical dosage forms. During the production of tablets, it is necessary to constantly monitor the critical process parameters and quality attributes. In the compressing phase critical process parameters that need to be monitored are: tablet press speed and compression force. It is also important that constant monitoring of process controls for thickness, hardness, diameter, friability and disintegration is performed.

During the production of tablets with a mass of 225 mg, an issue appeared due to insufficient thickness of tablets (2.60 mm to 3.20 mm) which resulted with problems in the feeding of tablets during the packaging process. Tablet thickness is determined by the diameter of the die, the amount of fill permitted to enter the die cavity, the compaction characteristics of the fill material, and the force or pressure applied during compression. A change in the diameter and thickness was deemed as an appropriate solution to the packaging problem.

The aim of this study was to change the diameter of the tablets from 9.00 mm to 8.00 mm in order to increase the thickness from 2.60 - 3.20 mm to minimum 3.20 mm and ensure a more efficient packaging process, without affecting the limits of hardness (6-11 kP) and disintegration time (max 10 min).

Materials and methods

For the purpose of this study, eleven experimental runs were performed at the development level.

In our R&D laboratory two types of punches with diameter of 8.00 mm are available: biconvex punches without break mark and flat punches with break mark on one side. The experiments performed were: four experiments using the flat punches and varying the compression force (7.50 kN and 10.00 kN) and tableting speed (4800 and 9600 tablets/hour), and seven experiments using the biconvex punches while varying the compression force (7.50 kN, 8.75 kN and 10.00 kN) and tableting speed (4800, 7200 and 9600 tablets/hour). All the experiments were performed on a laboratory rotary tablet press Korsch XL 100. The results of diameter, thickness, hardness and disintegration were evaluated.

After performing and analyzing the laboratory experiments, the next step was introducing the change of diameter and thickness on the industrial batch in the Production Department. The compressing process was performed on a rotary tablet press Fette 2090i in a Department of Production of Solid Dosage Forms. For the purpose of this study, 8.00 mm biconvex punches with break mark on one side were used. Three experiments were performed, varying the compression force. In the first experiment compressing was performed with compression force of 8.00 kN, in the second experiment 9.00 kN and in the third experiment the compression force used was 10.00 kN. In all three experiments, tableting speed was 50 000 tablets/hour and it was constant. The results of diameter, thickness, hardness and disintegration were evaluated. Additionally, the parameter friability was analyzed for the first and third experiment in order to determine the impact of the difference of hardness on the friability.

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Results and discussion

These experiments were carried out to determine the effect of the changes in the diameter and thickness on the other quality attributes of tablets. The diameter and shape of tablets depends on the punch diameter selected for tablet compression. There are various sizes and shapes of tablets and for the purpose of this study two types of punches were evaluated: biconvex punches without a break mark and flat punches with a break mark on one side. The results for the diameter for all tablets from experiments performed at the development level, regardless of the punches that were used, were in the range from 7.98 mm to 8.05 mm, which is satisfactory.

The other parameter, thickness, is an important process control for tablet packaging. Tablet thickness depends on the dosing height and compression force. The speed of compression can also affect the thickness. In the experiments where flat punches were used, the results for thickness were below the desired acceptance criteria (minimum 3.2 mm). The maximum value for the thickness 2.96 mm (SD 0.07). using these punches was achieved in the experiment where compression force of 7.50 kN was applied and the tablet press speed was 9600 tablets/hour In the experiments where biconvex punches were used, the results for thickness were satisfactory. The minimum value for the thickness (3.31 mm) using these punches was achieved in the experiment where compression force of 10.00 kN was applied and the tablet press speed was 4800 tablets/hour. The maximum value for the thickness (3.44 mm) was achieved in the experiment where compression force of 7.50 kN was applied and tablet press speed was 9600 tablets/hour (SD 0.05).

The compression force affects not only the thickness of tablets, but also their hardness, which is very important since it can affect disintegration and dissolution. The hardness of tablets is also important to predict the breaking point and structural integrity of a tablet under conditions of storage, transportation and handling before usage. The hardness of tablets depends on the dosing height, the distance between the upper and lower punch at the time of compression and the compression force.

The results for the hardness for all tablets from the experiments performed at the development level were satisfactory. For the first four experiments, where flat punches were used, a minimum value for hardness of 6 kP was obtained in the experiment where compression force of 7.50 kN was applied, and tablet press speed was 9600 tablets/hour. The maximum value for the hardness of 10 kP was obtained in the experiment where compression force of 10.00 kN was applied and tablet press speed was 9600 tablets/hour (SD 1.91).

For the experiments where biconvex punches were used, the minimum hardness of 6 kP was obtained in the experiment where compression force of 7.50 kN was applied and tablet press speed was 9600 tablets/hour. The maximum hardness of 10 kP was obtained in the experiment where compression force of 10.00 kN was applied and tablet press speed was 4800 tablets/hour (SD 1.58).

As it was mentioned before, the parameter hardness is very important, since it can affect the disintegration. For this reason, the disintegration was also analyzed, and all of the results were satisfactory. The maximum disintegration time (4 min and 5 s) was obtained in the experiment where hardness was 10 kP.

According to the obtained results, it was decided that biconvex punches with break mark will be used in the production of the industrial batches at the Production Department. The results for the quality attributes of the tablets in the three experiments of the industrial batch were satisfactory. The average value for the diameter was 8.02 mm (SD 0.03) and the average value for the thickness was 3.36 mm (SD 0.06). The minimum value for the hardness of 6 kP was obtained in the experiment where compression force of 8.00 kN was applied, and the maximum hardness of 7 kP was obtained in the experiment where compression force of 10 kN was applied (SD 0.80). In order to determine the effect on the compression force on the friability, additional analysis of the parameter friability was performed on experiments with the lowest (8 kN) and highest (10 kN) compression force. The results of friability (0.26%, 0.20%/) were similar for both experiments.

Conclusion

The packaging process was successfully improved with the aforementioned experiments. The results for the quality attributes showed that the changes in the diameter and thickness do not have negative effect on the other quality attributes of the tablets. Compression force range of 8 – 10 kN and speed of 50 000 tablets/hour are thus proven to be acceptable.

References

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