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Pharmacotechnical and Chemical Study of Paracetamol Sold in Kinshasa-DR Congo: Comparative Quality Assessment of Five Brands

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Abstract

Paracetamol/Acetaminophen was assessed in different 5 brands comparatively to study its physicochemical and pharmaceutical parameters. We also evaluated the similarity among those brands. Widely used as an antipyretic and analgesic agent to cure fever and pain, the therapeutic efficacy of this product depends on both physicochemical and pharmaceutical qualities which include its conformity to standard specifications according to the active ingredient dosage in the formulation. This research work aimed to assess comparatively 5 paracetamol brands tablet form sold in the Democratic Republic of the Congo (particularly in Kinshasa), on their physicochemical and pharmaceutical tests conformities compared to the standard specifications. Based on tests, we evaluated the uniformity of weight, disintegration time, friability, crushing strength (hardness), and the active ingredient dosage per brand. The tests were performed using the Sotax™ apparatus according to standard methods following the pharmacopoeia protocols. And according to the performed tests, only the fifth brand of Paracetamol coded P5 did not satisfy the friability test. About the hardness test, we have also observed the unconformity of three brands (P1, P2, and P3) while both P4 and P5 satisfied the test. This leads us to conclude that among all the studied brands, only P5 satisfy to all the tests either pharmacotechnically or chemically (identification and dosage). And this study allowed us to re-examine the equivalence concept between several princeps (original brand) with their generics since that similarity depends on many parameters that need to be improved during the manu-

facturing process including in-process analysis in all the phases of preparation to evaluate the rate of either active ingredient or inactive ingredient because each component can affect seriously the final pharmaceutical formulation quality.

Keywords

Quality Control, Paracetamol, Pharmacotechnical, Chemical Study

1. Introduction

Paracetamol is also known as 4-hydroxyacetanilide and is one of the widely used drugs among analgesic and antipyretic compounds [1]. It is available as an OTC product commonly used to manage fever and pain. Easier access to pain medication can be considered as a serious public health issue due to the highest usage of a drug such as Paracetamol by patients. Apart from the way of access by population, we can mention that safety, effectiveness, and efficacy of pharmaceutical formulation need to be guaranteed by the reliability to its quality and confirmed by evaluation tests according to official documentation like pharmacopoeias [1] [2].

Drugs and pharmaceutical devices productions are based on stipulated standards and those standards are elaborated through well-articulated current Good Manufacturing Practices (cGMP). Ensuring cGMP in the pharmaceutical formulation helps to maintain acceptable standards in terms of contents in active ingredients, stability requirements, and general quality recommendations [3]. Referring to the International Organization for Standardization (ISO) definition, the quality is a totality of features and characteristics of a product or service that bears its ability to satisfy stated or desired needs. And about the tablet, that quality is related to the common features and characteristics that allow it to meet requirements given in pharmacopoeia [4].

Hence, there is an increasing in terms of the circulation of poor quality drugs in recent decades, which results from the lack of effective quality control of products in markets. Several referential books set regulatory guidelines about the quality assessing of pharmaceutical products used for curing or preventing different diseases [5] (**Figure 1**).

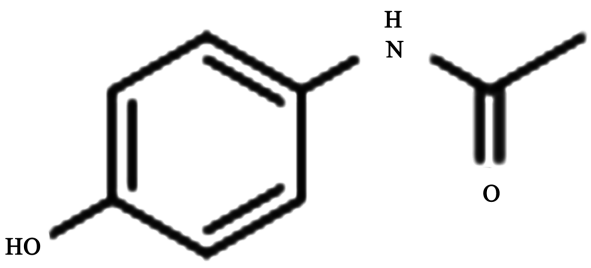


Figure 1. Paracetamol chemical structure [6].

Many literatures revealed recent techniques for Paracetamol determination by electroanalytical and spectrophotometric methods [7]. Paracetamol was determined in combination with other drugs in several matrixes using UV-Spectrometry. It is also stated in the literature that many analytical methods are used for the same purpose such as colorimetric and spectrofluorimetric methods. However, in pure state, the analysis of Paracetamol was conducted by spectrometry or high-performance liquid chromatography [6]. This study aimed to evaluate comparatively the quality of five Paracetamol brands being sold in the Democratic Republic of the Congo and focused on the physicochemical and pharmacotechnical parameters to highlight the quality issue related to those Paracetamol tablets brands.

In common, we know that many consumers select the most popular brand to cure their pain; this is the same with Paracetamol brands [8]. This is why the present study compared qualitatively different brands of tablets made of acetaminophen to know if those choices can be justified or really motivated. To perform our research, we referred to conventional tests for tablet formulations as per pharmacopoeias.

Generally, for ordinary tablets, the following pharmacotechnical parameters need to be determined: weight variation, disintegration time, friability, crushing strength, dissolution, drug assay, and the contents uniformity to confirm their quality [9].

2. Materials and Methods

2.1. Chemicals

Paracetamol raw material used as a standard for the establishment of identifying comparison to the samples was procured from Farmason Pharmaceuticals (Gujarat, India), Distilled water used for dilution and sample preparation was from Kim Pharma laboratory (Kinshasa, D. R. Congo); and different brands used to conduct the study were purchased from legal distributors officially established in the Democratic Republic of the Congo. And in this work, we identified them as P1, P2, P3, P4 and P5.

2.2. Materials

Following instrumentations and apparatus helped to conduct this research: a Gram precision® Serie SV analytical balance to weigh analytical materials and samples, a UV/vis Spectrophotometer branded Genesis 10S UV-vis spectrophotometer to perform analytical essay and compounds identification. All pharmaceutical tests (hardness, friability, tablets disintegration, tablets dissolution) were performed using Sotax™ type apparatus for each parameter evaluation, volumetric flasks, measuring cylinders, mortar, pestle, Whatman N°4 filter paper and glass funnel.

2.3. Sample Collection and Information

We identified five Paracetamol brands, marketed in the Democratic Republic of

the Congo from their local grossest (legal distributors) mostly based in Kinshasa. About 50 tablets per brand were registered for analytical purposes. And we have checked and noted all information for each one as the name of the manufacturer, the manufacturer location, batch number, manufacturing and expiring dates. To keep the manufacturer information confidential, we used codes to identify brands and for all of them, we used the letter P as Paracetamol, followed by a number as 1, 2, etc. to express the chronological order of collection.

After that collection, products were all kept under the same conditions before and during the analytical process to avoid every difference that can be related to an unregistered procedure on their manipulation.

2.4. Methods

Several analytical techniques can be used for Paracetamol determination from different matrixes which can be biological or pharmaceutical mixtures. In plasma, for example, Acetaminophen is currently estimated using spectrometric methods such as ultraviolet (UV) or separative methods combined with a good detection system like the gas-liquid chromatography (GLC) or high-performance liquid chromatography (HPLC) [10]. But in this research work, exclusively focused on the determination of pharmaceutical forms in particular tablet forms, we have only used ultraviolet spectrophotometry as an analytical method either in the identification of Paracetamol or for its quantification in brands under study.

2.5. Practical Procedures

To assess the quality and performance of the batches of a brand in comparison with one another, different tests should be taken. And this is the case with Paracetamol tablets, which were submitted to compendial and non compendial tests to establish a formal comparison based on the analysis of studied parameters.

2.6. Physical and Pharmaceutical Tests

These tests include weight uniformity, hardness and diameter, friability, disintegration time and dissolution test [11].

2.6.1. Weight Uniformity

This test's purpose is to estimate the uniformity of the weight for each batch of the product that is reflecting the uniformity of the content of the drug in all the formulation batches. This is also to know the weight variation between tablets in batch. The test is performed on 20 tablets individually weighed and also collectively, the weight recorded and the mean of each group calculated. Once this is done, the evaluation consists of a decision about the batch. If two tablets among 20 are outside of ±5% of the calculated mean, the tablets (batch) are considered to have failed in the weight variation test [7] [12].

In the present study, this procedure was respected and one result met our sa-

tisfactory decision, tablets were crushed into power and kept in containers.

2.6.2. Disintegration Test

This is to evaluate the tablet breaking process into small particles as part of the prior step of the dissolution. It is a very important test for coated and uncoated tablets because it can affect the absorption of drugs [13]. In this research work, we transferred 15 ml of de-ionized water into a 50 ml beaker and heated in a water bath to 37˚C and maintained it at the same temperature. Related results will be presented in the following part of this paper in the results and discussion point.

2.6.3. Friability

We studied this parameter to evaluate the tablets' ability to withstand abrasion along with packaging or handling operations and during transportation. We've weighted 20 paracetamol tablets randomly picked and dusted, and we placed them in the friabilator of Sotax™ brand and submitted them to rotation (about 50 per minute). After that, tablets were re-weighted then we calculated the loss expressed in percent.

$$\%F = \left[1 - \left(\text{Weight after rotation} / \text{Initial weight}\right)\right] \times 100 \quad [14].$$

2.6.4. Hardness and Tablets Diameters

This test was performed with five tablets (one tablet from each of the brands under research), the crushing strength was determined and the average was calculated using collected data.

We placed every time, one tablet vertically in the Sotax™ hardness tester and the load applied in their radial ax, and then we noted the weight and load required to break the tablet. This operation was repeated all the time that required for each brand tablet.

2.7. Quality Control Examinations

This examination includes the entire performed tests for the determination of different Paracetamol brands under this study:

- **Identification test:**

The quantity of Paracetamol powder obtained after crushing tablets is weighted for each brand sample. This is to contain about 500 mg of Paracetamol accurately weighted. That powder is placed in 10 ml of ethanol and filtered. After evaporation and drying, the residue was collected and mixed with 10 ml of water and 0.5 ml $FeCl_3$ 2%. A blue color appearance reveals the presence of Paracetamol. The obtained results for each studied brand will be presented below in this work.

- **Paracetamol assay:**

Several methods can be used to operate for Paracetamol quantification and most of them are costly and expensive for quality control purposes in the context of our countries because of the equipment and sophisticated apparatus they can request. However, the least expensive methods to perform that determination are

revealed to be less sensitive with a lack of precision for serious quality studies [15].

In this research study, we used a sensitive, accurate and affordable method that required a low-cost reagent as a solvent for the dilution of the sample. The Paracetamol was assayed by UV spectrophotometry with all the collected brand samples and we present below different steps of the operating procedure.

1) The mean weight was determined for each brand sample using the weighted sum of twenty tablets divided by twenty.

2) We crushed ten tablets among twenty and weighted the powder quantity containing accurately 150 mg of Paracetamol from each brand.

3) We transferred into different 200 ml volumetric flasks all the five samples and labeled them.

4) In each volumetric flask, we added 50 ml of sodium hydroxide 0.1M and 100ml of distilled water.

5) The mixture was sonicated for fifteen minutes to dissolve Paracetamol in solution then we completed the volume with water to the gauge.

6) We filtered each solution into a clean beaker, and then we diluted each sample with distilled water until we obtained 7.5 µg/ml for every sample.

7) After UV spectrophotometer calibration, we started reading for determination of Paracetamol absorbance at 257 nm into a glass cuvette and we repeated the same operation for five brands, trice per sample and then we calculated the concentration using the Beer-Lambert formula and expressed it in percentage according to the British Pharmacopoeia 2008, H. M. Stationary Office, London, 2008, Vol. 3, pp 2968.

Notice that the UV spectra were determined for each Paracetamol brand and this was done trice per brand to observe the absorption curve as we present the below. It was done by running the apparatus between 200 and 400 nm on samples collected three times for each brand to observe the allure.

3. Statistical Analysis

Collected data from this study were treated and analyzed using Microsoft Office Excel 2010 and ANOVA to compare the results between several repetitions with different brands of Paracetamol with a confidence interval of 95% and $p = 0.05$.

4. Results and Discussion

4.1. The Weight Average

As stated above, this was to determine the weight uniformity and to establish the weights' variation expressed in percentage. The following figure and table give the tablets' weights and their variation according to the weighting manipulation for all the five brands under this study (**Figure 2**).

Each brand corresponds to a color and for each of them, there are twenty similar histograms giving an allure of the weight variation during the weighting operation of twenty tablets. Below this figure, we present a synthetic table giving all the weights values per unit of the tablet weighted, the weight variation and the corresponding variation expressed in percentage (**Table 1**).

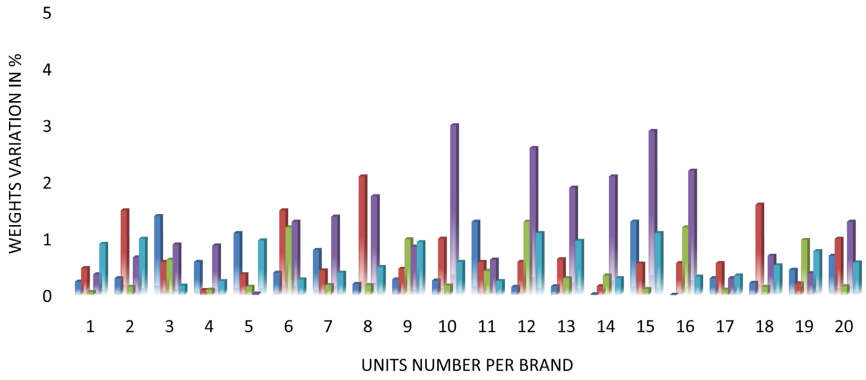


Figure 2. Weight variation of twenty tablets for 5 brands.

Table 1. Weights variation for five brands of Paracetamol.

P1 (w. mean) 562.45 mg			P2 (w. mean) 574.8 mg			P3 (w. mean) 600.11 mg			P1 (w. mean) 589.30 mg			P1 (w. mean) 675.34 mg		
W/Unit	D	D in %	W/Unit	D	D in %	W/Unit	D	D in %	W/Unit	D	D in %	W/Unit	D	D in %
563.8	1.35	0.24	577.6	2.79	0.48	600.5	0.39	0.06	591.5	2.2	0.37	681.5	6.16	0.91
560.6	1.85	0.3	583.5	8.69	1.5	601.0	0.89	0.15	593.3	4	0.67	668.2	−7.14	−1
554.5	7.95	1.4	578.2	3.39	0.59	603.9	3.79	0.63	583.8	−5.5	−0.9	676.5	1.16	0.17
559.1	3.35	0.59	575.3	0.49	0.09	599.5	0.61	−0.1	594.5	5.2	0.88	677.0	1.66	0.25
556.2	6.25	1.1	572.7	−2.11	−0.37	599.2	0.91	−0.15	589.5	0.2	0.03	668.8	−6.54	−0.97
560.2	2.25	0.4	584.0	9.19	1.5	592.7	−7.41	−1.2	597.2	7.9	1.3	677.2	1.86	0.28
566.9	4.45	0.8	572.3	−2.51	−0.44	599.0	−1.11	−0.18	581.1	−8.2	−1.39	672.6	−2.74	−0.4
561.3	1.15	0.2	562.5	−12.31	−2.1	599.0	−1.11	−0.18	599.6	10.3	1.75	678.7	3.36	0.5
560.9	1.55	0.28	577.5	2.69	0.47	606.1	5.99	0.99	584.2	−5.1	−0.86	681.7	6.36	0.94
561.0	1.45	0.26	568.8	−6.01	−1	608.2	1.01	0.17	571.3	−18	−3	671.3	−4.04	−0.59
569.8	7.35	1.3	571.4	−3.41	−0.59	602.7	2.59	0.43	593.0	3.7	0.63	677.0	1.66	0.25
563.3	0.85	0.15	571.4	−3.41	−0.59	592.2	−7.91	−1.3	573.8	−15.5	−2.6	667.9	−7.44	−1.1
563.4	0.95	0.16	578.5	3.69	0.64	602.0	1.89	0.3	600.6	11.3	1.9	681.8	6.46	0.96
562.3	0.15	0.02	573.9	−0.91	−0.16	598.0	−2.11	−0.35	601.8	12.5	2.1	677.4	2.06	0.3
569.8	7.35	1.3	571.6	−3.21	−0.56	599.4	−0.71	−0.11	571.8	−17.5	2.9	667.8	−7.54	−1.1
562.4	0.05	0.008	578.1	3.29	0.57	593.0	−7.11	−1.2	602.8	13.5	2.2	677.6	2.26	0.33
560.8	1.65	0.3	571.5	−3.31	−0.57	599.5	−0.61	−0.1	587.4	−1.9	−0.3	673.0	−2.34	−0.35
561.2	1.25	0.22	584.1	9.29	1.6	599.2	−0.91	−0.15	585.2	−4.1	−0.7	678.9	3.56	0.53
565.0	2.55	0.45	573.6	−1.21	0.21	606.0	5.89	0.98	587.0	−2.3	−0.39	680.6	5.26	0.78
566.4	3.95	0.7	568.8	−6.01	−1	601.1	0.99	0.16	597.2	7.9	1.3	671.4	−3.94	−0.58

w. mean = weight mean; D = variation; D in % = variation in percentage; mg = milligram and W/Unit = weight per unit (individual tablet weight).

The following table gives the statistical analysis of the weight uniformity test with all the five studied brands (Table 2).

4.2. Disintegration Results

This test allowed us to decide on the dissolution of tablets after administration by measuring the necessary time they take before complete disaggregation. It is an important test that helps to predict the absorption process. The following histogram and table show us graphically how the disintegration time varies between brands and the related figures in terms of disintegration time (Figure 3).

As we can see in Figure 2, the disintegration times related to Paracetamol brands under study showed good performance as the time did not exceed the reference fixed into the Pharmacopoeia and that time varied with a brand like P4 that disintegrated completely after 480 seconds or 8 minutes and was the highest time read for this test since other brands performed less than that duration. P3 gave a low figure in terms of disintegration time among all the samples under study.

The disintegration time of tablets from the five brands varied between 57 seconds to 480 seconds (8 minutes) leads us to conclude that all the brands are satisfied with the test according to the International pharmacopoeia, as their results are acceptable since that disintegrating time should not exceed 15 minutes (900 seconds), while studied samples performed the test along 8 minutes for the most lasting brand, as all the remaining samples did it during a time interval less or equal to 282 seconds (Table 3).

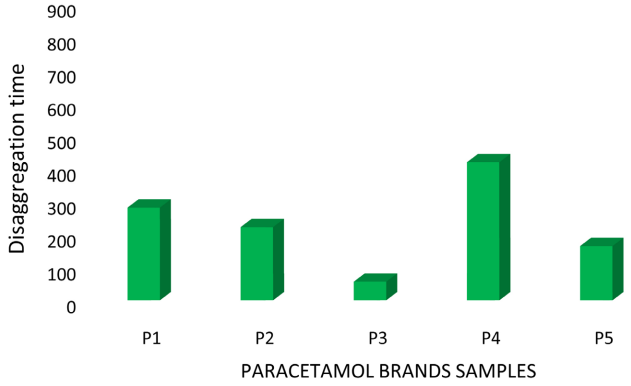


Figure 3. Disintegration times variation between five brands.

Table 2. Statistical parameter related to weight variation test.

	Brand P1	Brand P2	Brand P3	Brand P4	Brand P5
Mean	562.45 mg	574.76 mg	600.11 mg	589.3 mg	675.34 mg
Variance	14.27	26.02	17.02	88.92	22.11
SD	3.77	5.1	4.12	9.42	4.7
RSD (%)	0.67%	0.89%	0.68%	1.6%	0.69%

SD: standard deviation and RSD: relative standard deviation.

Table 3. Disintegration time of tablets.

Repetition	Time (s)/P1	Time (s)/P2	Time (s)/P3	Time (s)/P4	Time (s)/P5
First	266	218	65	480	159
Second	300	210	45	540	180
Third	280	240	60	420	165
Mean	282	223	**57**	**480**	**168**

4.3. Hardness and Tablets Diameters

This test allowed us to predict the crushing strength of tablets from each of the five brands using the hardness tester. We considered the test as a failure if the tablets are outside of 39.23 N (4 Kgf) - 118 N (12 Kgf) intervals. The table below gives hardness values for each of the five brands.

Tables 4-8 shows that two Paracetamol brands, P4 and P5, have hardness values that fitted the referential standard according to that test. But differently, brands P1, P2 and P3 did not satisfy the conformity criterion as shown respectively their hardness figures 127.7, 155 and 124.4 Newton.

4.4. Friability

The tablets were placed in a Sotax™ friabilator and subjected to the tumbling actions at 50 rotations per minute for five minutes. After that, they were taken to be the time no granule on the apparatus mesh. The following table presents the rate of loss after the friability test established after tablets weighting by comparison to their weights before.

Tables 9-13 shows that all the branded samples had good friability valuable less than 1% as the first brand gave 0.4385%, the second 0.2037%, the third gave 0.7075% and the fourth 0.0787%. Only the fifth brand gave an exceeding value out of the acceptance value which is 1%. This last sample gave the wrong value (mean value of 1.687% as friability) that was above the acceptable figure according to the international pharmacopoeia given above.

4.5. Quality Control Results

4.5.1. Identification

The following table shows the identification tests results according to the five Paracetamol brands under study. This is obtained proceeding through the above protocol of examination from the official pharmacopoeia (Table 14).

The reactions above revealed the Paracetamol presence in all the studied brands by the blue color appearance after each brand reacts with Ferric Chloride and this allowed us to continue our research to the next step for the drug quantification in different studied brands.

4.5.2. Quantitative Assay

As stated above, the Paracetamol assay in all the brands was performed using ultraviolet spectrophotometry for determining the molecule absorbance at 257 nm

Table 4. Tablets hardness and diameters brand P1.

	1	2	3	4	5	6	7	8	9	10	Mean ± SD	% RSD
Hardness in NEWTON	142	164	160	144	163	144	151	155	161	165	155 ± 0.09	5.821
	163	123	145	163	158	178	139	164	167	152	155 ± 0.15	10.267
	140	154	168	160	139	160	141	154	164	168	155 ± 0.11	7.285
											155 ± 0.12	7.791
Diameter	17.11	17.17	17.07	17.23	17.1	17.07	17.1	17.07	17.12	17.09	17.1 ± 0.05	0.298
	17.09	17.05	17.08	17.07	17.11	17.06	17.08	17.06	17.03	17.09	17.0 ± 0.02	0.134
	17.18	17.07	17.07	17.08	17.04	17.07	17.06	17.08	17.07	17.06	17.0 ± 0.04	0.220
											17.1 ± 0.04	0.217

Table 5. Tablets hardness and diameters brand P2.

	1	2	3	4	5	6	7	8	9	10	Mean ± SD	% RSD
Hardness in NEWTON	109	124	114	123	121	118	118	111	124	115	117.7 ± 0.05	4.567
	126	121	117	133	131	133	127	129	129	127	127.3 ± 0.05	3.989
	146	144	142	144	148	135	143	129	122	129	138.2 ± 0.08	6.397
											127.7 ± 0.06	4.984
Diameter	10.94	10.98	10.96	10.97	11.02	11.01	10.95	11.02	10.99	10.95	10.9 ± 0.02	0.273
	11.1	11.02	11.16	10.98	10.99	10.95	10.97	11.01	10.97	11.1	11.0 ± 0.07	0.638
	10.96	11.01	11	10.96	11.1	10.98	11.11	10.98	11.06	11.12	11.0 ± 0.06	0.576
											11.0 ± 0.05	0.496

Table 6. Tablets hardness and diameters brand P3.

	1	2	3	4	5	6	7	8	9	10	Mean ± SD	% RSD
Hardness in NEWTON	127	122	123	102	105	122	122	129	121	118	119.1 ± 0.08	7.388
	123	139	109	139	120	145	124	115	109	125	124.8 ± 0.12	10.112
	112	130	142	126	136	148	116	130	131	122	129.3 ± 0.11	8.550
											124.4 ± 0.11	8.683
Diameter	12.52	12.58	12.8	12.57	12.53	12.52	12.54	12.54	12.47	12.53	12.6 ± 0.09	0.712
	12.48	12.43	12.47	12.44	12.47	12.55	12.48	12.47	12.55	12.49	12.5 ± 0.04	0.318
	12.66	13.11	12.45	12.44	12.46	12.45	12.43	12.43	12.46	11.12	12.4 ± 0.05	4.010
											12.5 ± 0.02	1.680

Table 7. Tablets hardness and diameters brand P4.

	1	2	3	4	5	6	7	8	9	10	Mean ± SD	% RSD
Hardness in NEWTON	113	115	126	97	117	108	119	108	98	115	**111.6 ± 0.09**	8.127
	119	108	100	109	113	121	112	119	118	124	**114.3 ± 0.07**	6.363
	118	122	93	107	117	118	119	108	110	146	**115.8 ± 0.13**	11.740
											113.9 ± 0.09	8.743

Continued

Diameter	12.56	12.53	12.54	12.54	12.57	12.73	12.51	12.5	12.57	12.63	12.6 ± 0.06	0.538
	12.5	12.49	12.47	12.44	12.49	12.46	12.44	12.46	12.45	12.46	12.5 ± 0.02	0.169
	12.45	12.44	12.57	12.48	12.5	12.47	12.48	12.57	12.48	12.42	12.5 ± 0.05	0.399
											12.51 ± 0.05	0.369

Table 8. Tablets hardness and diameters brand P5.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean ± SD**	**% RSD**
Hardness in NEWTON	56	45	44	46	42	33	46	46	41	33	43.2 ± 0.07	15.539
	29	42	50	35	46	36	32	41	29	35	37.5 ± 0.07	18.866
	39	34	39	44	46	40	36	38	35	40	39.1 ± 0.04	9.603
											39.9 ± 0.06	14.669
Diameter	13.16	13.1	13.19	13.24	13.14	13.17	13.18	13.18	13.17	13.19	13.2 ± 0.04	0.274
	13.09	13.09	13.13	13.08	13.08	13.07	13.11	13.14	13.14	13.06	13.1 ± 0.03	0.223
	13.11	13.08	13.08	13.11	13.12	13.08	13.09	13.06	13.12	13.07	13.1 ± 0.02	0.164
											13.1 ± 0.03	0.220

Table 9. Friability test results brand 1.

The mass of 10 Tablets before test (g)	The mass of 10 Tablets after test (g)	**FRIABILITY (%)**	Referential norm
6.766	6.759	**0.1035**	≤1%
6.776	6.77	**0.0885**	≤1%
6.783	6.78	**0.0442**	≤1%
	Mean	**0.0787**	≤1%

Table 10. Friability test results brand 2.

The mass of 10 Tablets before test (g)	The mass of 10 Tablets after test (g)	**FRIABILITY (%)**	Referential norm
6.008	5.957	**0.84887**	≤1%
6.051	6.012	**0.64452**	≤1%
6.039	6.001	**0.62924**	≤1%
	Mean	**0.70754**	≤1%

Table 11. Friability test results brand 3.

The mass of 10 Tablets before test (g)	The mass of 10 Tablets after test (g)	**FRIABILITY (%)**	Referential norm
5.649	5.627	**0.38944946**	≤1%
5.625	5.602	**0.40888889**	≤1%
5.64	5.611	**0.5141844**	≤1%
Mean	**0.43750758**	≤1%	

Table 12. Friability test results brand 4.

The mass of 10 Tablets before test (g)	The mass of 10 Tablets after test (g)	**FRIABILITY (%)**	Referential norm
5.724	5.718	**0.1048218**	≤1%
5.71	5.697	**0.22767075**	≤1%
5.738	5.722	**0.2788428**	≤1%
	Mean	**0.20377845**	≤1%

Table 13. Friability test results brand 5.

The mass of 10 Tablets before test (g)	The mass of 10 Tablets after test (g)	**FRIABILITY (%)**	Referential norm
5.865	5.826	0.66496164	≤1%
6.02	5.863	2.60797342	≤1%
5.984	5.877	1.7881016	≤1%
	Mean	**1.68701222**	≤1%

Table 14. Paracetamol brands Identification.

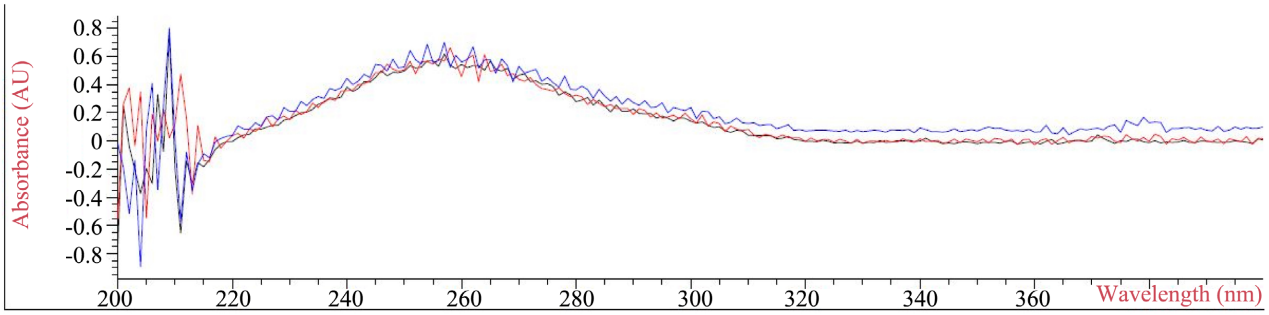
Reaction between the brand and reagent	**Blue color appearance**	**Results**
P1 + 2 ml of $FeCl_3$ 2%.	+	Paracétamol presence
P2 + 2 ml of $FeCl_3$ 2%.	+	Paracétamol presence
P3 + 2 ml of $FeCl_3$ 2%.	+	Paracétamol presence
P4 + 2 ml of $FeCl_3$ 2%.	+	Paracétamol presence
P5 + 2 ml of $FeCl_3$ 2%.	+	Paracétamol presence

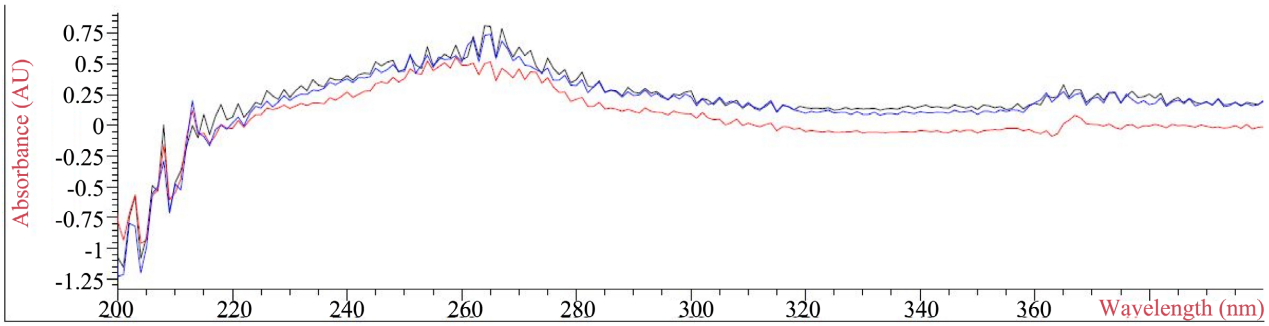
as the maximum wavelength of absorption. The drug concentration expressed in percentage was calculated using the Beer-Lambert formula. The following results were obtained with five studied brands:

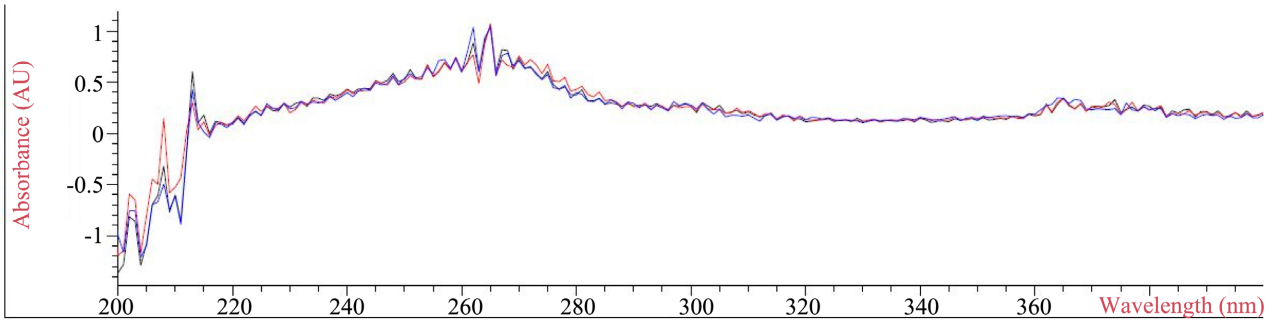
Referential norm: 95% - 105% (USP 37 NF 32)

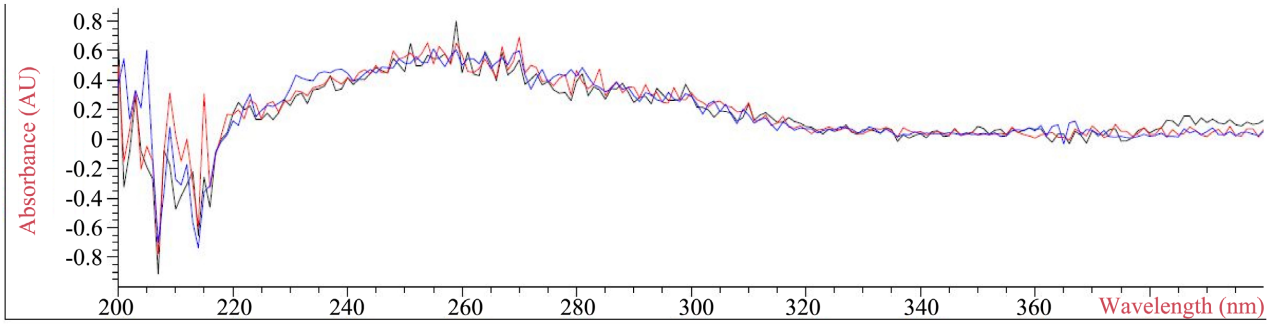
According to the results above, all the Paracetamol brands studied were appropriated to the human care since their concentrations were comprised in the acceptance limit of tolerance according to the Pharmacopoeia which tolerates the interval from 95% to 105% (Table 15).

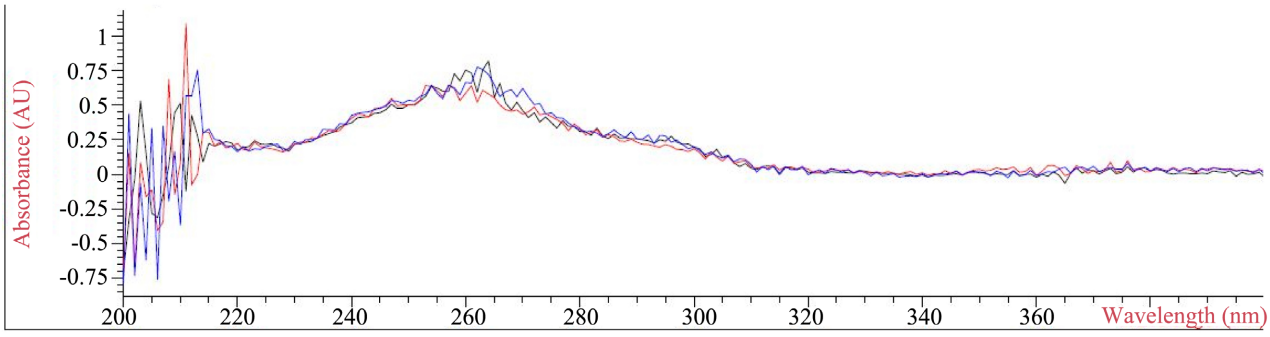
Each dosage form was assayed trice and the presented results were calculated using the means. This was the same with the ultraviolet absorbance spectra observed for all the five brands under study that we present below (**Figure 4**).


Absorbance (AU)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
200
220
240
260
280
300
320
340
360
Wavelength (nm)


Absorbance (AU)
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
-1.25
200
220
240
260
280
300
320
340
360
Wavelength (nm)


Absorbance (AU)
1
0.5
0
-0.5
-1
200
220
240
260
280
300
320
340
360
Wavelength (nm)


Absorbance (AU)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
200
220
240
260
280
300
320
340
360
Wavelength (nm)


Absorbance (AU)
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
200
220
240
260
280
300
320
340
360
Wavelength (nm)

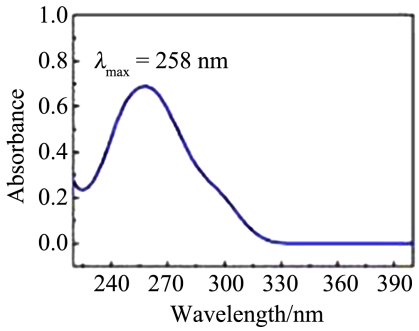


Figure 4. Paracetamol absorption spectra (Reference versus brands samples).

Table 15. Sample quantification results.

Brand	The found absorbance	Theorical concentration (µg/ml)	Found concentration (µg/ml)	Drug concentration (% CV, n = 3)
P1	**0.628**	7.5	7.55	**100.70 ± 0.31**
P2	**0.627**	7.5	7.54	**100.52 ± 0.25**
P3	**0.547**	7.5	7.49	**99.90 ± 0.46**
P4	**0.549**	7.5	7.5	**100.00 ± 0.11**
P5	**0.700**	7.5	7.54	**100.52 ± 0.29**

5. Conclusions

This study aimed to evaluate comparatively Paracetamol brands (Five branded samples) sold in the Democratic Republic of the Congo particularly in Kinshasa in order to assess their pharmacotechnical and physicochemical quality. Since that quality depends on several parameters which need to be controlled using appropriate tools, from their arrival in the laboratory until their complete analysis via the sampling process.

According to the referential books (International Pharmacopoeia for pharmacotechnical tests and US pharmacopoeia for chemical analysis), all those brands contained Paracetamol as an active ingredient as revealed by the identification test using a colorimetric reagent. Also, the assay results allowed us to observe that it is crucial to get attentive while producing tablets since among all the studied brands, there are certain pharmacotechnical gaps that are commonly responsible for the quality failure. Also, those chemical analysis results could not blind us as the quality concept for a drug includes more than identification and quantitative assay. This leads us to note a certain number of deviations since some of the studied brands did not satisfy the conformity related to the quality control and this was the case for the friability test and hardness for some of them.

In prospect, we suggest further research in quality control of this product including rapid and affordable analytical tools by development for example some

Near-Infrared methods for the online or in-process analysis. This will allow a good monitoring and continuous surveillance of products during their manufacturing.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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