Stability of an aspirin in the aspirin+curcumin admixture at different storage conditions

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ABSTRACT

Aims: The pure stability of aspirin in the aspirin (100 μg/mL) only and aspirin (100 μg/mL) +curcumin(600 μg/mL) admixture without any ingredient under two solvents (distilled water, DW and normal saline, NS), three storage temperatures(25˚C, 4˚C and -20˚C) and periods (1st, 3rdand 7thdays) was evaluated.
Study Design: The injectable DW- and NS-aspirin containing solutions in the laboratory cap polyethylene bottle were stored and evaluated at controlled temperature (25˚C, 4˚C and -20˚C) during 7 days.
Methodology: Effects of admixture compounds, periods of storage and temperature of storage on the concentrations of active compound (aspirin) were analyzed. The concentration of aspirin in each solution was determined by stability-indicating high-performance liquid chromatography (HPLC)-ultraviolet (UV) detection. A 1.0 mL volume of each sample was withdrawn and reconstituted with 3.0 mL of ethanol and directly injected into HPLC system immediately after filtration at 1st, 3rdand 7th days for analysis. The stability of the solutions was determined by calculating the percentage of the initial aspirin concentrations remaining at each test condition and periods. Stability was defined as the retention of at least 90% of the initial aspirin concentration.
Result: The concentration of aspirin of the aspirin only and aspirin+curcumin admixture solutions remained at least 90% of original without any color change or precipitation in the DW and NS solution at 4˚C and -20˚C throughout 7 day period and showed instability that decreased gradually below 90% of original concentrations after 1 day at 25˚C in the two solutions.
Conclusion: Two kinds of solutions of aspirin only and aspirin+curcumin admixture, in DW and NS, showed different stability dependence on temperature of storage that means maintained stability at 4˚C and -20˚C and did not show effect of admixture of curcumin on aspirin stability during 7 days except 25˚C.

Keywords: Aspirin; Stability; Curcumin admixture; HPLC.

1. INTRODUCTION

The chemical stability of a drug is of great importance since it becomes less effective as it undergoes degradation. Also, drug decomposition may yield toxic by-products that are harmful to the patient. Acetylsalicylic acid (ASA) decomposes rapidly in solutions of ammonium acetate or of the acetates, carbonates, citrates or hydroxides of the alkali metals. ASA is stable in dry air, but gradually hydrolyses in contact with moisture to acetic and salicylic acids. In solution with alkalis, the hydrolysis proceeds rapidly and the clear solutions formed may consist entirely of acetate and salicylate [1]. Daily Aspirin's effect on cancer has been widely studied, particularly its effect on colorectal cancer. Multiple meta-analyses and reviews have concluded that regular use of aspirin reduces the long-term risk of CRC incidence and mortality [2, 3, 4, 5]. In addition, experiments were carried out to measure the synergistic effects of a combination of aspirin with other chemopreventive agents for the anticancer benefit [6, 7, 8, 9,10]. Therefore, it is necessary to evaluate the physical and chemical stabilities of aspirin in order to determine the formulation of optimal dosage form that balances chemopreventive efficacy with safety of aspirin in combination with other agents. The purpose of this study is to provide information about the physical and chemical stability of aspirin in aspirin and

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curcumin of admixture under two solvents, various storage temperatures and periods. Thus, the study evaluated the stability of aspirin in the aspirin (100 μg/mL) only and aspirin (100 μg/mL) + curcumin (600 μg /mL) admixture without any ingredient under two solvents (distilled water, DW and normal saline, NS), three storage temperatures (25˚C, 4˚C and -20˚C) and periods (1st, 3rd and 7th days)

2. MATERIALS AND METHODS

2.1 Chemicals and reagents

Aspirin was purchased from Sigma-Aldrich Co. (St. Louis, MO, USA) and Curcumin was purchased from Now Foods (Bloomingdale, USA), respectively. Acetonitrile, formic acid and ethanol were all HPLC-grade and purchased from Sigma Co. (St. Louis, MO, USA) while other reagents and solvents used were of analytical grade. All aqueous solutions including the buffer for the HPLC mobile phase was prepared with water that purified by Milli-Q water purification system (Millipore, Milford, MA, USA). The filter with pour size of 0.22 μm (Millipore, Milford, MA, USA) was used for filtration of mobile phase and 0.45 μm (PALL, USA) for filtration of standard and sample solution.

2.2 Sample preparation

Solutions of the designated samples (aspirin 2.5 mg, aspirin 2.5 mg and curcumin 15 mg) and diluents (to final volume of 25 mL with normal saline and distilled water) were prepared (Table 1). At the time of preparation of each test solutions, 1 mL of samples were collected at specified time intervals; 0, 1st, 3rd and 7th day, and added in 15 mL falcon tubes and stored in RT(25±2℃), CT(4±2℃), and FT (-20±2℃) until analyzed. A 1.0 mL volume of each sample was withdrawn and reconstituted with 3.0 mL of ethanol and directly injected into HPLC system immediately after filtration at 1, 3 and 7 days for analysis.

Table 1. Study protocol

Compound (μg/mL)	Period(day)	Temperature(℃)	Diluent [a]
Aspirin (100) only	1, 3, 7	-20, 4, 25	DW, NS
Aspirin (100)+Curcumin (600) admixture	1, 3, 7	-20, 4, 25	DW, NS

[a] *DW = distill water, NS = 0.9% sodium chloride solution.*

2.3 HPLC method

The concentration of aspirin in each sample solution was determined using a stability-indicating HPLC assay method based on several references [11, 12, 13, 14, 15, 16]. The chromatographic system used in the analysis consisted of an isocratic solvent delivery pump (Model 515 pump,Waters Scientific Co., USA), an autosampler(Model Nanospace SI-2 Autosampler, Shiseido Co., Japan) and analytical column Cadenza CD-C18 (250 x 4.6 mm, 3 μm) and guard column Unison US-C18, (5 x 2 mm, 5 μm) (Imtakt Corporation, Kyoto, Japan). A variable wavelength ultraviolet detector (Model 486 Tunable Absorbance Detector, Waters Scientific Co., USA) set at 220 nm and the integration of the chromatograms (Model dsCHROM® Data module, Do-Nam instrumental Co., Seoul, Korea) were used. The mobile phase consisted of distilled water, acetonitrile and formic acid. (v/v/v, 45/55/0.05, pH 3.3). The flow rate of mobile phase was 0.8ml/min. The method was validated for linearity, precision (inter-day and intra-day), accuracy and selectivity [17]. The experiment was repeated five times on the same day and five consecutive days to determine inter- and intra-day precisions [18]. Linearity, accuracy and precision were evaluated by determining five concentrations of aspirin in range of 6.25~100 μg/mL. Linear regression analysis of peak area and concentration yielded a good correlation coefficient ≥0.999. Inter-and intra-day precision were expressed as the percent relative standard deviation (% RSD). The accuracy was expressed as the percent ratio between the experimental and nominal concentrations for each sample.

2.4 Standard solutions

A 1 mg/mL of stock solution of aspirin was prepared by dissolving in 75% (V/V) ethanol/DW. Standard samples of aspirin were prepared by diluting the stock solution with 75% (V/V) ethanol/DW to concentrations of 6.25, 12.5, 25, 50 and 100 µg/mL. The injection volume was 5 µL. The standard samples were assayed to repeat five times on the same day as an external standard method.

2.5 Sample analysis

Each aspirin sample solution was prepared as described. A 5 µL of sample were injected into the HPLC system, and each sample was assayed in three times a day. Effects of admixture compounds, periods of storage and temperature of storage on the concentrations of active compound (aspirin) were analyzed. The samples were visually inspected for color change and precipitate formation was evaluated on each day of analysis.

2.6 Data analysis

The stability of aspirin in the aspirin only and aspirin+curcumin admixture solutions was determined by calculating the percentage of the initial aspirin concentrations remaining at each test condition and hours. Stability was defined as the retention of at least 90% of the initial aspirin concentration.

2.7 Statistical analysis

Experimental data were expressed as the mean ± standard deviation (S.D.). Differences the concentrations of aspirin for 7 days investigated at the three different temperatures were performed with one-way ANOVA using SPSS version 18.0. Statistical significance was set at $p<0.05$.

3. RESULTS AND DISCUSSION

The linearity could be established for aspirin in the concentration range of 6.25~100 µg/mL (r^2= 0.9998, Fig.1A). Table 2 lists the percent relative standard deviation (% RSD) data obtained on analysis of the samples (n=5) on the same day and on consecutive days (n=5). The results were within limits (%RSD <10) shown in Table 2. As evident, the %RSD values were <9.84% and <2.10% for inter-day and intra-day results, respectively. Accuracies were 96.6~102.2% and 98.6~101.0%for inter-day and intra-day, respectively, meaning that the method was sufficiently precise and accurate.

Table 2. Validation data and retention time (RT) under conditions of HPLC Assays

Range (µg/mL)		Validation (n=5)			RT (min)	
			Inter-day	Intra-day	Aspirin	Degradation Products
Aspirin	6.25-100[a]	Precision (% RSD)	0.76~9.84	0.70~2.10	4.6	5.3
		Accuracy (%)	96.6~102.2	98.6~101.0		

[a] *Samples were diluted with 75% ethanol*

The retention time of the intact aspirin and the degradation product were about 4.6 and 5.3 minutes (Fig.1B, Fig. 1C).The aspirin undergoes hydrolysis in solutions at room temperature with the resultant degradation products being salicylic acid and acetic acid [13].

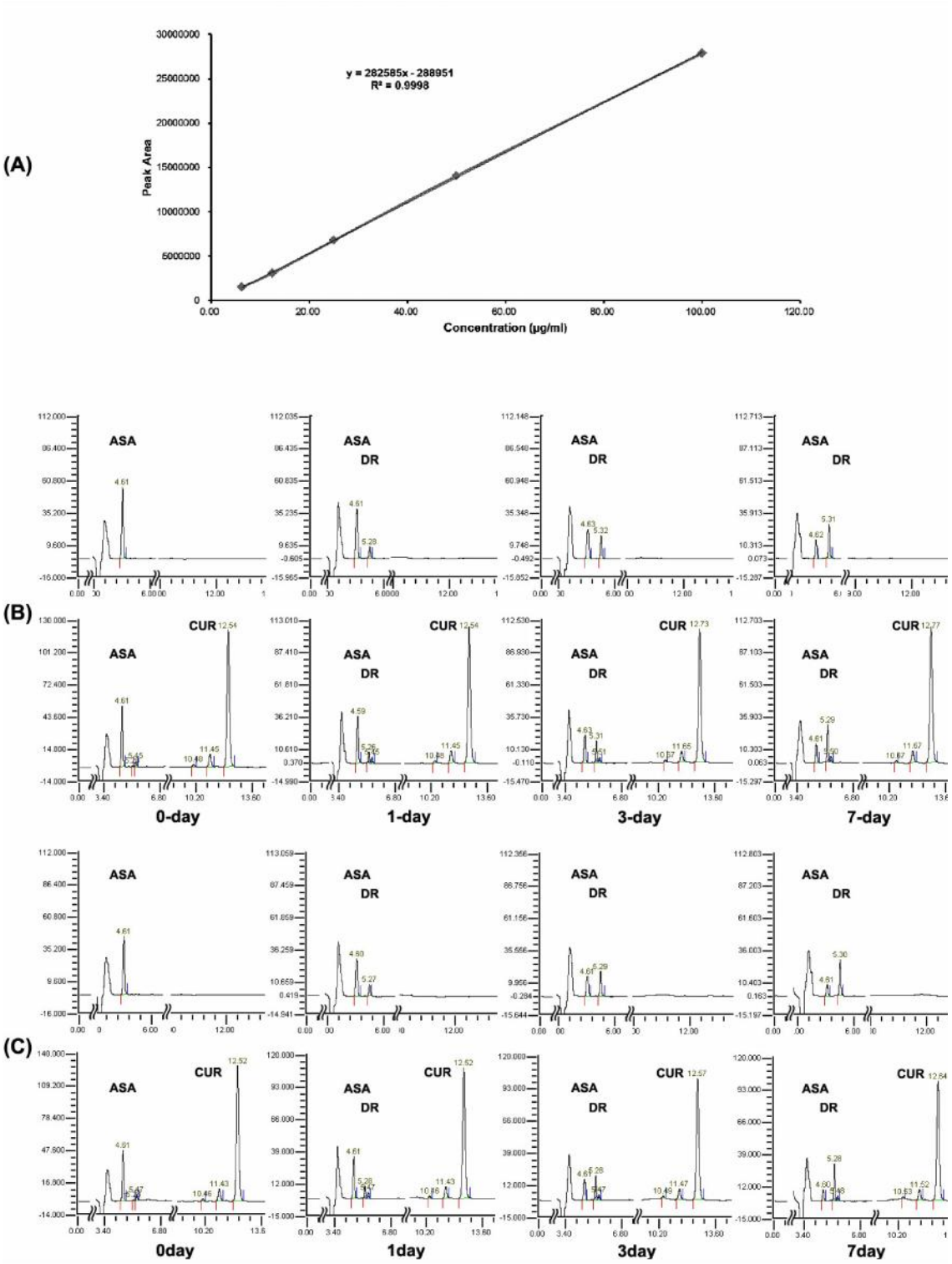

Fig. 1. (A) Calibration curve for the determination of aspirin concentrations (6.25~100 μg/mL). (B) Chromatogram of aspirin(25 μg/mL in DW) and asprin+curcumin admixture (25μg/mL+150μg/mL in DW) and (C) Chromatogram of aspirin(25 μg/mL in NS) and asprin+curcumin admixture (25μg/mL+150μg/mL in NS) after 0, 1st, 3rd and 7th days of storage at 25℃.

ASA=aspirin, DR= degradation product and CUR= curcumin.

The concentration of aspirin which were observed at analytic time of each day during 7 days for each

of the designated samples (aspirin only and aspirin+curcumin admixture), solution (DW and NS) and storage conditions are listed in Table 3.

In the aspirin in DW solution, the mean values of concentration were statistically ($p < 0.05$) different from 1st to 7th day among temperatures. The difference mean values of 7th day were higher than the other day. These were 19.14±0.41 (in 25℃), 3.38±2.54(in 4℃), and 0.55±0.51 (in -20℃). In the aspirin in NS solution, the mean values were statistically ($p < 0.05$) different according to the three temperature of storage except 1st day. But the mean values of 1st day among temperatures tended to be slightly high in 25℃. The difference mean values of 7th day were 16.29±0.75 (in 25℃), 1.93±0.49(in 4℃), and 1.63±1.09 (in -20℃). In the aspirin+curcumin admixture in DW solution, the mean values of concentration were statistically ($p < 0.05$) different from 1st to 7th day among temperatures. The difference mean values of 7th day were 18.71±2.13 (in 25℃), 0.91±0.58 (in 4℃), and -0.83±1.18 (in -20℃). In the aspirin+curcumin admixture in NS solution, the mean values of concentration were statistically ($p < 0.05$) different from 1st to 7th day among temperatures. The difference mean values of 7th day were 17.05±4.42 (in 25℃), 0.93±1.32 (in 4℃), and 0.26±0.61 (in -20℃).

The differences mean values showed that the concentration of aspirin decreased. Therefore, the concentration of aspirin reduced according to change of temperature and time, regardless of solution type and the admixture of curcumin.

The concentration of Aspirin remained by a minimum of 22% of the 0day concentration under RT (25 ± 2℃), 90% of the 0day concentration under CT(4℃ ± 2℃) and 94% of the 0day concentration under FT (-20℃ ± 2℃).

Table 3. Stability of aspirin in the aspirin only and aspirin+curcumin admixture solutions at 25, 4 and -20℃

Nominal concentration (μg/mL), Diluent [a]	Time (day)	Temperature (℃)	Concentration (μg/mL)[b]	% Remaining	*p*-Value
Aspirin, (25), DW	0	25	26.44±0.53	100.0	
		4	26.84±0.97	100.0	
		-20	31.14±1.51	100.0	
	1st	25	21.57±0.93	81.6^{A}	0.00
		4	24.37±0.85	90.8^{B}	
		-20	31.02±0.85	99.6^{C}	
	3rd	25	14.94±0.44	56.5^{A}	0.00
		4	24.44±1.38	91.0^{B}	
		-20	32.98±3.53	105.9^{C}	
	7th	25	7.30±0.24	27.6^{A}	0.00
		4	23.46±1.68	93.9^{B}	
		-20	30.59±1.19	98.2^{C}	
Aspirin, (25), NS	0	25	21.11±0.76	100.0	
		4	20.85±0.55	100.0	
		-20	29.72±1.32	100.0	
	1st	25	18.73±2.12	88.7^{A}	0.14
		4	20.26±0.97	97.1^{A}	
		-20	27.99±0.19	94.2^{A}	
	3rd	25	10.68±0.27	50.6^{A}	0.00
		4	19.56±0.54	93.8^{B}	
		-20	28.10±0.92	94.5^{B}	
	7th	25	4.82±0.18	22.8^{A}	0.00
		4	18.92±0.31	90.7^{B}	
		-20	28.10±0.36	94.5^{B}	

Aspirin + Curcumin, (25+150),DW	0	25	26.66±2.32	100.0	
		4	23.41±1.21	100.0	
		-20	30.23±4.04	100.0	
	1st	25	20.78±1.89	78.0^{A}	0.00
		4	23.60±2.43	100.8^{B}	
		-20	30.11±4.02	99.6^{B}	
	3rd	25	15.07±1.87	56.5^{A}	0.00
		4	22.57±0.66	96.4^{B}	
		-20	29.70±3.57	98.2^{B}	
	7th	25	7.95±0.24	29.8^{A}	0.00
		4	22.49±1.51	96.1^{B}	
		-20	31.06±2.92	102.8^{B}	
Aspirin + Curcumin, (25+150),NS	0	25	23.19±5.16	100.0	
		4	19.64±1.89	100.0	
		-20	29.23±2.10	100.0	
	1st	25	20.18±2.69	87.0^{A}	0.00
		4	19.09±3.19	97.2^{A}	
		-20	31.42±2.76	107.5^{B}	
	3rd	25	12.87±2.07	55.5^{A}	0.00
		4	18.40±2.28	93.7^{B}	
		-20	28.01±2.62	95.8^{B}	
	7th	25	6.14±0.77	26.5^{A}	0.00
		4	18.72±3.01	95.3^{B}	
		-20	28.97±1.91	99.1^{B}	

[a]*DW = distilled water, NS = 0.9% sodium chloride injection.*

[b]*Mean ± S.D.(n=7)*

**P*<0.05 as compared to the 0day concentration (n=7). Values are mean±S.D. (n=7)

A,B,C = Scheffe grouping (means with the same letter are not significantly different)

The results of this study indicate the chemical stability of aspirin solution. Therefore, the concentration of aspirin of the aspirin only and aspirin+curcumin admixture solutions remained at least 90% of original without any color change or precipitation in the DW and NS solution at 4˚C and -20˚C throughout 7th day period and showed instability that decreased gradually below 90% of original concentrations after 1st day at 25˚C in the two solutions.

4. CONCLUSION

The objective of this study was to provide information about the physical and chemical stability of aspirin only and aspirin+curcumin admixture under two solvents, three storage temperatures and periods by HPLC assay method.

This study showed different stability of aspirin that depend on temperature of storage and period and did not show effect of admixture of curcumin on aspirin stability during 7 days except 25˚C. However, it is only chemical stability of aspirin during one week. Therefore, further study is needed for the evaluation of chemical stability during a longer period of time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHOR'S CONTRIBUTIONS

This work was carried out in collaboration between all authors. Authors JSK and HJK designed the study and wrote the protocol. Author JSK, HJK and MAK carried out the Aspirin stability testing, performed the statistical analysis and wrote the first draft of the manuscript. Authors YSP and SHK managed the literature searches and overall revision and submission. Authors read and approved the final manuscript.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

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