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## Study of bioequivalence of post coital contraceptions (Levonorgestrel 0.75 mg)

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**Chompootaweep S, Leepipatpibul S. Study of bioequivalence of post coital contraceptions (Levonorgestrel 0.75 mg). Chula Med J 2003 Feb; 47(2): 87 - 95**

- Objective** : *To determine whether a local product (BW<sub>2</sub>) has equal efficacy to its innovator's product (Postinor®) by comparative the bioavailability of the two types of contraceptive tablets.*
- Setting** : *Department of Pharmacology, Department of Obstetrics and Gynaecology, Faculty of Medicine, Chulalongkorn University, Bangkok.*
- Design** : *Clinical Trial, Randomized crossover design.*
- Material and Methods** : *Twelve, healthy female volunteers aged 21- 40 years were randomly divided into two groups. Subjects in Group 1, by randomization took one tablet of a local product (BW<sub>2</sub>) or the innovator's product. The drug free interval between the period was two weeks. The order of drug administration for subjects in Group II was reversed. The blood sample was obtained from antecubital according to schedule, and serum levonorgestrel concentration was analyzed by radio-immunoassay. The pharmacokinetic analysis of serum levonorgestrel concentration from each treatment was established. The comparative bioavailability of the two products was determined by two-way analysis of variance (ANOVA) for a crossover design.*

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**Result** : - The mean AUC (area under the curve) of local product ( $BW_2$ ) and innovator's product (Postinor®) were  $2.20 \pm 0.13$  and  $2.15 \pm 0.11$  ng.h/ml, respectively. The 90 % confidence interval of difference of AUC mean (log transformed data) was 107.004 - 118.748 %

- The mean  $C_{max}$  (peak serum concentration) for  $BW_2$  was  $1.23 \pm 0.06$  ng/ml and for Postinor was  $1.16 \pm 0.11$  ng/ml. The 90 % confidence interval of difference of  $C_{max}$  mean (log-transformed data) was 108.59 - 126.53 %

The acceptance criteria for consideration of the bioequivalence of two products is when each 90 % confidence interval is within 80 - 125 %.

**Conclusion** : The study revealed that only 90 % confidence interval of difference of AUC mean was in the criteria of acceptance, but 90 % confidence interval difference of  $C_{max}$ , the upper limit was slightly higher than the criteria, so we could not conclude that the local product ( $BW_2$ ) was bioequivalent to innovator's product (Postinor®)

**Keywords** : Postcoital contraception, Bioequivalence.

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สุนา ชมพูทวีป, สมัย ลิพิพัฒนไพบูลย์. การศึกษาชีวสมมูลของยาคุมกำเนิดหลังร่วมเพศ (Levonorgestrel 0.75 มิลลิกรัม). จุฬาลงกรณ์เวชสาร 2546 ก.พ;47(2): 87 - 95

- วัตถุประสงค์** : เพื่อศึกษาอาสาสมัครเลียนแบบ ( $BW_2$ ) มีประสิทธิภาพในการรักษาเท่ากับ ยาดันแบบ (Postinor<sup>®</sup>) โดยศึกษาเปรียบเทียบค่าทางเภสัชจลศาสตร์ ของยาทั้งสองชนิด
- สถานที่ทำการศึกษา** : ภาควิชาเภสัชวิทยา และภาควิชาสูติศาสตร์-นรีเวชวิทยา คณะแพทย- ศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
- รูปแบบของการศึกษา** : การศึกษาทางคลินิกเชิงทดลองแบบข้ามเชิงสุ่ม
- วัสดุและวิธีการ** : อาสาสมัครสตรี 12 คน อายุระหว่าง 21-40 ปี แบ่งออกเป็น 2 กลุ่ม แบบสุ่มให้ได้รับยาสามัญ ( $BW_2$ ) และยาดันแบบ (Postinor<sup>®</sup>) ในการ บริหารยาครั้งแรกจากนั้นจะเว้นระยะ 2 สัปดาห์ เพื่อการบริหารยา ครั้งที่สอง โดยอาสาสมัครจะได้รับยาอีกชนิดหนึ่งสลับกับการบริหารยา ครั้งแรก มีการเจาะเลือดหาระดับยา Levonorgestrel ในช่วงระยะต่าง ๆ โดยใช้วิธี radio immunoassay และนำผลมาวิเคราะห์ระดับยามาเพื่อ หาค่าเภสัชศาสตร์ของยาทั้งสอง สำหรับการวิเคราะห์ด้านชีวสมมูลของ ยาทั้งสอง ใช้วิธี two way analysis of variance (ANOVA) สำหรับ การศึกษาเชิงทดลองแบบข้ามเชิงสุ่ม
- ผลการศึกษา** : ค่าเฉลี่ยของ AUC (area under the curve) ของยาสามัญเลียนแบบ ( $BW_2$ ) และยาดันแบบ (Postinor<sup>®</sup>) มีค่าเท่ากับ  $2.20 \pm 0.13$  และ  $2.15 \pm 0.1$  ng h/ml ตามลำดับ และค่า 90 % confidence interval of difference ของค่าเฉลี่ยของ AUC (log transformed data) คือ 107.004 - 118.748 %
- : ค่าเฉลี่ยของ  $C_{max}$  (ค่าความเข้มข้นสูงสุด) ของยาสามัญเลียนแบบ ( $BW_2$ ) เท่า กับ  $1.23 \pm 0.06$  ng/ml และของยาดันแบบ (Postinor<sup>®</sup>) เท่ากับ  $1.16 \pm 0.11$  ng/ml สำหรับค่า 90 % confidence interval of difference ของค่าเฉลี่ยของ  $C_{max}$  (log transformed data) คือ 108.59 - 126.53 %
- : การพิจารณาว่ายาทั้งสองจะมีชีวสมมูลกันหรือไม่นั้นมีหลักเกณฑ์ ดังนี้คือค่า 90 % confidence interval for the difference ของค่าเฉลี่ย  $C_{max}$  และ  $AUC_{\infty}$  (log transformed data) จะต้องอยู่ภายใน 80 - 125 %
- สรุป** : การศึกษาพบว่ายาสามัญเลียนแบบ ( $BW_2$ ) มีค่า 90 % confidence interval of difference of AUC mean ที่อยู่ในเกณฑ์ แต่สำหรับค่า 90% confidence interval of difference of  $C_{max}$  นั้นพบว่าอยู่สูงกว่าเกณฑ์ จากผลดังกล่าวนี้ จึงสรุปได้ว่ายาสามัญเลียนแบบ ( $BW_2$ ) นั้น ไม่มี ชีวสมมูลกับยาดันแบบ (Postinor<sup>®</sup>)

In the beginning of the new millennium, the world population has more than 6 billions, there is high growth rate in developing countries. Thailand, one of the countries in South East Asia is successful in National Family Planning program, has the population growth rate less than 1.6 %.<sup>(1)</sup> There is a cafeteria of choice for Thai women to contraceptives, e.g. oral pills, IUD, injectable, implant, etc. While most contraceptives are appropriate for use before sexual intercourse. At present there are several methods of contraception that a women can use within a short time after unprotected intercourse often so-called "morning after pills" / "Post coital contraception". These regimens are better named emergency contraceptives.<sup>(2)</sup>

In Thailand, the levonorgestrel emergency contraceptive regimen is one of the effectiveness for the temporary contraception, that are increasing demand among Thai youth couples. This regimen is more popular than the "Yuzpe regimen".

The levonorgestrel regimen consists of 0.75 mg levonorgestrel taken in two doses of twelve hours apart and started within 48 hours after an unprotected intercourse. The mechanism for prevention of pregnancy is unclear. It is believed that this regimen has a high dose of progestin, it will increase the movement of the fallopian tubes, or it may change endometrium not suitable for fertilized ovum. Almost it does not inhibit ovulation.<sup>(3)</sup>

In a multicenter trial conducted by the World Health Organization, the observed failure rate per treated cycle for 0.75 mg dose was 0.8 %.<sup>(4)</sup> This rate is similar to that of other reports for emergency postcoital contraception. Bleeding and spotting are the most reported adverse events. Other side effects are headache, dizziness, and nausea.<sup>(5-10)</sup>

In this randomized crossover study, two types of 0.75 mg levonorgestrel tablets were compared. Postinor<sup>®</sup> (Gedeon Richter Ltd, Hungary) which is registered for postcoital contraception in several countries, and a comparable levonorgestrel pill produced in Thailand (BW<sub>2</sub>, Thai Pharmaceutical Factory, Bangkok). The present paper described a comparative bioavailability of these two types of tablets. The objective was to determine whether the local product (BW<sub>2</sub>) has equal efficacy to its innovator's product (Postinor<sup>®</sup>).

#### Materials and Methods

Permission for the study was given by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University. Informed consent was obtained from each of the volunteers.

Twelve normal and healthy female volunteers, aged between 21-40 years, were randomly divided into two groups. All subjects had regular menstrual cycles ( $28 \pm 7$  days) and had not used any steroidal agents nor lactated for at least three months prior to the admission. No other drugs were taken during the course of the study. A medical history was taken from each subject before entering the study and a full medical and gynecological examinations, were performed. Normal liver and kidney functions were confirmed by routine laboratory tests.

This study was a single dose of the randomized crossover design. Twelve female volunteers were randomly divided into two groups. Subjects in Group I, took one tablet of innovator's product or local product according the assignment of treatment by randomization. The drug free interval between the period was two weeks. The order of drug administration was reversed for subjects in Group II.

Both the Innovator's product (Postinor<sup>®</sup>) and local product (BW<sub>2</sub>) tablets contained 0.75 mg levonorgestrel. The BW<sub>2</sub> were batched lot No AA and Postinor<sup>®</sup> were the batched lot No T 86264 Mfd. 06 1998.

Prior to the dosing events, the subjects had fasted overnight, starting from midnight of the previous day. At about 7-8 a.m., the drug was administered to subjects with 200 ml of tap water. A standardized lunch and snack were given to each subject after blood samplings were drawn at 4, and 8 hours, respectively.

From each woman, a blood sample was obtained from antecubital vein immediately before and at 1,1.5,2,2.5,3,3.5,4,6,10 and 24 hour after taking the tablet. Blood samples were allowed to clot at room temperature at least 30 minutes and then centrifuged. The separated serum was stored at -20°C until analyzed for levonorgestrel content by radioimmunoassay.<sup>(11)</sup> The intraday and inter-day precision were validated. The % coefficient of variation (c.v.) for intraday and inter-day were not more than 15% and 20 %, respectively. This method was also validated for accuracy and sensitivity.

The pharmacokinetic analysis of individual serum levonorgestrel concentration from each treatment was established by graphing method. The peak serum concentration,  $c_{max}$  and the time to peak serum concentration,  $t_{max}$  were directly observed from the data. The area under the serum concentration-time curve, AUC was calculated using the linear trapezoidal rule and extended to infinite time.<sup>(12)</sup>

### Statistical Analysis

Comparative bioavailability of the local product (BW<sub>2</sub>) of 0.75 mg levonorgestrel tablet in

the present study relative to its innovator's product (Postinor<sup>®</sup>) was assessed using the relevant pharmacokinetic parameters,  $c_{max}$  and  $AUC_{0-\infty}$ . Both were transformed to logarithmic scale for statistical analysis.

The difference of the corresponding  $\log c_{max}$  and  $\log AUC_{0-\infty}$  between the two products were determined by two-way analysis of variance (ANOVA) for a crossover design<sup>(13)</sup> at the significant level of  $\alpha = 0.05$ .

The 90 % confidence interval (Two one-sided tests) for the differences of  $c_{max}$  and  $AUC_{0-\infty}$  means based on log transformed data were calculated.<sup>(14,17)</sup>

### Acceptance Criteria<sup>(12,15,16)</sup>

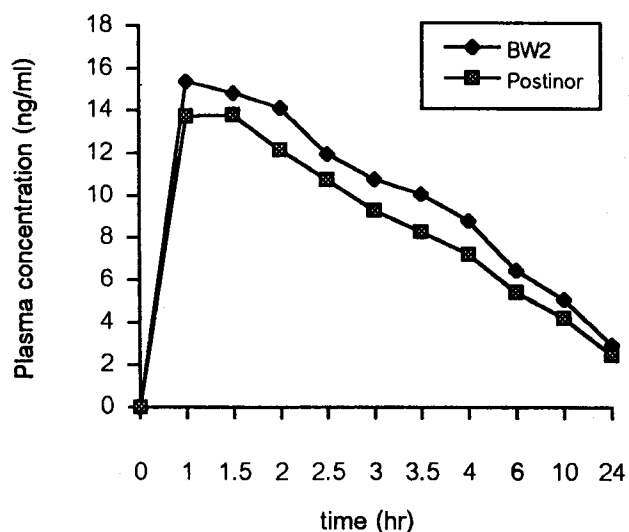
The two products were considered to be of bioequivalence when each 90% confidence interval is within 80 -125 %.

### Results

Twelve female subjects, average mean age was 33.5 years, ranged 24-40 years. Their average weight and height were 52.7 kg and 158.6 cm, respectively. Their average Body Mass Index (BMI) was 21.1. All subjects had regular menstrual cycles. The results of their laboratory tests for liver and kidney functions were within normal limits.

The values for serum levonorgestrel concentrations of the two products were shown in Table 1 and Table 2 and mean concentration-time curve were plotted in Fig.1.

Absorption was rapid in most subjects and maximum serum concentrations levonorgestrel were achieved in less than 2 hours in eleven women after both products. Serum concentration in all subjects were slightly higher when taking BW<sub>2</sub> (Table 1, Table 2, Fig1).



**Figure 1.** Mean serum levonorgestrel concentration-time curve from 12 subjects following oral administration of 0.75 mg tablets of BW<sub>2</sub> and Postinor<sup>®</sup>

The pharmacokinetic parameters used for the evaluation of bioequivalence between BW<sub>2</sub> and Postinor<sup>®</sup> were the peak serum levonorgestrel concentration,  $c_{max}$ , the time to peak serum levonorgestrel concentration,  $t_{max}$ , and the area under the serum levonorgestrel concentration-time curve, AUC. The first two parameters ( $c_{max}$ ,  $t_{max}$ ) referred to rate of drug absorption; meanwhile the later (AUC) indicated the extent or amount of drug absorption into systemic circulation. All these parameters were derived from individual serum levonorgestrel concentration-time profile. Their mean values were summarized in Table 3.

**Table 1.** Serum levonorgestrel concentration (ng/ml) from 12 subjects following oral administration of 0.75 mg of tablets of BW<sub>2</sub> (Thai pill).

Subject	Time (hr)											
	No.	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	6.0	10.0	24.0
1	0	9.00	14.07	16.04	11.79	8.55	7.69	7.38	4.81	3.82	1.92	
2	0	15.22	9.09	6.79	7.54	5.08	4.60	4.01	2.94	1.68	1.43	
3	0	10.72	13.38	12.60	10.76	11.40	7.45	4.54	3.96	3.10	1.53	
4	0	21.67	21.78	21.77	19.92	16.33	15.94	14.24	12.21	10.97	6.37	
5	0	16.78	14.11	11.93	9.80	8.38	7.74	7.52	4.63	3.75	1.90	
6	0	12.11	16.53	14.50	10.88	12.81	14.10	10.66	8.33	6.87	3.72	
7	0	14.98	17.68	16.48	15.30	14.24	13.31	11.52	10.80	5.46	3.78	
8	0	15.05	10.30	11.76	10.67	11.46	16.03	13.87	8.40	7.66	4.05	
9	0	12.45	14.43	14.85	11.64	9.32	9.52	8.56	4.93	5.23	2.11	
10	0	18.03	14.47	15.88	13.36	11.87	9.43	9.15	7.66	4.41	3.18	
11	0	20.10	16.76	15.95	12.04	10.55	8.60	7.61	4.83	4.90	3.47	
12	0	18.31	15.43	10.93	9.96	9.45	6.70	6.66	4.00	3.33	1.92	
$\bar{x}$	0	15.37	14.84	14.13	11.97	10.79	10.09	8.81	6.46	5.10	2.95	
S.D.	0	3.83	3.31	3.71	3.15	2.96	3.80	3.26	2.96	2.47	1.44	

**Table 2.** Serum levonorgestrel concentration (ng/ml) from 12 subjects following oral administration of 0.75 mg of tablets of Postinor®

Subject	Time (hr)										
	No.	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	6.0	10.0
1	0	11.72	12.85	10.98	9.63	11.28	9.64	6.85	6.18	4.80	2.37
2	0	14.65	12.33	10.73	9.81	6.87	5.43	5.71	3.58	3.22	2.31
3	0	11.22	10.07	9.05	7.10	6.81	5.53	4.68	4.39	2.89	1.75
4	0	22.53	19.92	17.78	14.48	12.64	11.13	9.69	6.54	5.69	3.49
5	0	13.60	13.70	10.56	10.73	9.50	10.15	7.87	4.85	3.19	1.79
6	0	19.99	16.97	14.82	12.84	13.52	9.52	9.14	8.00	6.36	3.44
7	0	14.95	18.27	16.18	16.01	12.60	11.23	9.61	8.69	6.33	3.81
8	0	6.33	12.68	12.62	12.22	13.20	12.93	11.06	6.06	5.25	3.50
9	0	12.19	11.78	11.32	10.50	8.56	8.04	7.64	4.46	3.31	1.63
10	0	15.91	16.25	11.12	7.45	1.48	2.32	3.04	4.61	2.64	1.72
11	0	12.66	11.00	13.37	11.82	9.36	7.76	7.34	5.19	4.61	2.45
12	0	9.18	9.69	7.16	6.28	5.53	5.55	3.99	2.31	2.08	1.49
$\bar{X}$	0	13.74	13.79	12.14	10.74	9.28	8.27	7.22	5.41	4.20	2.48
S.D.	0	4.40	3.31	3.00	2.95	3.66	3.08	2.48	1.80	1.49	0.86

**Table 3.** Mean pharmacokinetic parameters ( $\bar{X} \pm SD$ ) of levonorgestrel from 12 subjects following oral administration of 0.75 mg tablets of BW<sub>2</sub> and Postinor®

Parameters	Brands		90% Confidence Interval of Mean Differences
	BW <sub>2</sub>	Postinor®	
AUC (ng.h/ml)	2.20 ± 0.13*	2.15 ± 0.11*	107.004– 118.748
C <sub>max</sub> (ng/ml)	1.23 ± 0.06*	1.16 ± 0.11*	108.59 - 126.53
T <sub>max</sub> (hr)	1.54 ± 0.72**	1.38 ± 0.57**	

N = 12

\* Log transformed data

\*\* Observed data

**Discussion**

Table 3 showed the mean pharmacokinetic parameters ( $\bar{X} \pm SD$ ) levonorgestrel from 12 subjects following oral administration of 0.75 mg tablets of BW<sub>2</sub> and Postinor®. The mean AUC of BW<sub>2</sub> and

Postinor® were 2.20 ± 0.13 and 2.15 ± 0.11 ng/ml, respectively. The 90% confidence interval of difference of AUC mean (log transformed data) was 107.004-118.748 %. This result was within 80 -125 % for criteria of acceptance.



The mean  $C_{max}$  for  $BW_2$  was  $1.23 + 0.06$  ng/ml and for Postinor<sup>®</sup> was  $1.16 + 0.11$  ng/ml. The 90% confidence interval of difference of  $C_{max}$  mean (log transformed data) was 108.59-126.53 %. The upper bound was 126.53 % slightly higher for criteria of acceptance (>125 %). Probably, the  $C_{max}$  had very high variation.

The mean  $T_{max}$  for  $BW_2$  and Postinor<sup>®</sup> were  $1.54 \pm 0.72$  and  $1.38 \pm 0.57$  hours, respectively. The difference of time of peak serum levonorgestrel concentration in this study was 11.59 % which was in criteria which it is not more than 20 %.

At present,<sup>(17)</sup> the two pharmacokinetic parameters,  $C_{max}$  and AUC are used to be considered for bioequivalence of two products. Each of 90 % confidence interval for difference of  $C_{max}$  and AUC means (log transformed data) should be within 80 - 125 %. This study revealed that only 90 % confidence interval of difference of AUC mean was in the criteria of acceptance, but 90% confidence interval of difference of  $C_{max}$ , the upper limit was slightly higher than the criteria. It may be that the product " $BW_2$ " had a higher rate of drug absorption than the innovator's product (Postinor<sup>®</sup>). In conclusion, we could not conclude that the  $BW_2$  was bioequivalent to Postinor<sup>®</sup>.

### Acknowledgments

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### References

1. สาธารณสุข, กระทรวง, การประเมินผลงานอนามัยครอบครัวในแผนพัฒนา ฉบับที่ 7. กองอนามัยกระทรวงสาธารณสุข, 2539
2. Hoffmann KO. Postcoital contraception : experiences with ethinylloestradiol/norgestrel and levonorgestrel only. In : Harrison RF, Bonnar J, Thompson W, eds. Fertility and Sterility. Lancasster (U.K): MTP Press, 1983:311 - 6
3. Van Look PFA. Postcoital contraception : a cover-up story. In : Diczfalusy E, Bygdeman, M, eds. Fertility Regulation Today and Tomorrow. New York : Raven Press, 1987: 29 - 42
4. Bhattacharjee SK, Romeo J, Kononova ES, Pretnar-Darovec A, Saraya L, Shi YE, Prasad RN, Bartfai G, Boukhris R, Van Look PF, et al. Postcoital contraception with levonorgestrel during the peri-ovulatory phase of the menstrual cycle. Task Force on Post-ovulatory Methods for Fertility Regulation. Contraception 1987 Sep; 36(3): 275 - 86
5. Seregely G. Results of a multicentre trial of Postinor. Ther Hung 1982: 30(2): 72 - 8
6. Rinehart W. Postcoital contraception-an appraisal. In : Series J. Population Reports. Washington: George Washington University Medical Center 1976: 141
7. He CH, Shi YE, Xu JQ, Van Look PF. A multicenter clinical study on two types of levonorgestrel tablets administered for postcoital contraception. Int J Gynecol Obstet. 1991 Sep;36(1): 43 - 8
8. Shi YE, Zheng SH, Zhu YH, He CH, Yu PP, Fotherby K. Pharmacokinetic study of levonorgestrel used as a postcoital agent. Contraception 1988 Apr; 37(4): 359 - 69
9. He CH, Shi YE, Liao DL, Zhu YH, Xu JQ, Matlin SA,

- Fotherby K, Van Look PF. Comparative cross-over pharmacokinetic study on two types of postcoital contraceptive tablets containing levonorgestrel. *Contraception* 1990 May; 41(5): 557 - 67
10. von Hertzen H, Piaggio G, Van Look PF. Emergency contraception with levonorgestrel or the Yuzpe regimen. *Lancet* 1998; 352(12): 1939.
11. Ahsan R, Sufi SB, Cekan S. Laboratory method manual for the RIA of levonorgestrel, norethisterone, medroxyprogesterone acetate. WHO Collaborating Center for Research in Human Reproduction (WHO CCR) and reference service in the immunoassay of hormone in human reproduction. 1988:19 - 32
12. Guidance statistical procedure for bioequivalence studies using a standard two-treatment crossover design. Division of Bioequivalence, Office of Generic Drugs. CDER USFDA, 1992: 1 - 12
13. Fisher AC, Wallenstein S. Crossover designs in medical research. In : Buncher CR, Tsay JY, eds. *Statistics in the Pharmaceutical Industry*, 2<sup>nd</sup> ed. New York: Marcel Dekker, 1994: 193 - 206
14. Dighe SV, Adams WP. Bioequivalence : A United States Regulatory Perspective. In : Welling PG, Tse FLS, Dighe SV, eds. *Pharmaceutical Equivalence*. New York: Marcel Dekker, 1991: 367 - 80
15. Weiner DL, Yuh L. Bioavailability studies. In : Buncher CR, Tsay JY, eds. *Statistics in the Pharmaceutical Industry*. 2<sup>nd</sup> ed. New York: Marcel Dekker, 1994: 237
16. Yuh L. Statistical consideration for bioavailability/ bioequivalence studies. In : Welling PG, Tse FLS, eds. *Pharmacokinetics Regulatory/ Industrial-academic Perspectives*. 2<sup>nd</sup> ed. New York : Marcel Dekker, 1995: 479 - 502