RESEARCH ARTICLE
Open Access

Journal of Veterinary and Animal Sciences
ISSN (Print): 0971-0701, (Online): 2582-0605
https://doi.org/10.51966/jvas.2024.55.2.418-424

Assessment of functional benefits of *kaalan*-A traditional food of Kerala#

K. B. Divya [1]*, S.N. Rajakumar[1], P. Sujith[2], A.K. Beena[1], M P. Divya[1], P. Sudheer Babu[1], V. Ramnath [3] and B. Sheela Karalam[4]

Department of Dairy Technology,
Verghese Kurien Institute of Dairy and Food Technology, Thrissur-680 651
Kerala Veterinary and Animal Sciences University
Kerala, India

Citation: Divya, K.B., Rajakumar, S.N., Sujith, P., Beena, A.K., Divya,M.P. Babu, P.S., Ramnath, V. and Sheela, K.B. 2024. Assessment of functional benefits of *Kaalan*-A traditional food of Kerala. *J. Vet. Anim. Sci.* **55**(2):418-424
DOI: https://doi.org/10.51966/jvas.2024.55.2.418-424

Received: 05.01.2024 *Accepted: 24.02.2024* *Published: 30.06.2024*

Abstract

Kaalan, a regional dairy product renowned in the central regions of Kerala, holds cultural significance but faces waning popularity due to its laborious preparation and limited understanding. The absence of literature necessitates further exploration into its quality aspects, characteristics and standard preparation methods to elevate kaalan from a mere side dish to a functional food. This study aimed to quantify the non-nutritional constituents like dietary fibre and phytochemicals and to assess antioxidant activity of kaalan. The functional profile of kaalan revealed high dietary fibre (4.84±0.0.46 per cent), total polyphenols (14.747±.043mg GAE/g of sample), flavonoids (6.703±.023mg CTE/g sample) and curcumin content (13.63±0.03 ppm). An antioxidant activity of 4.812±0.025 GAEwas observed that distinguishes it as a functionally superior food product. The content of calcium oxalate, the anti-nutritional factor found in elephant foot yam was significantly reduced. Further investigations are warranted to unravel its complete health potential, positioning kaalan as a promising addition to health-conscious diets.

Keywords: *Kaalan, traditional, phytochemicals, dietary fibre, antioxidant*

Kaalan or *kurukkukaalan* is an indispensable item of the renowned Kerala style feast-*sadya*. This regional dairy product is very famous in the central regions of Kerala. It is made with vegetables like elephant foot yam (EFY) and raw plantain, sour buttermilk, coconut and spices.

#Part of PhD thesis submitted to Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala

1. *Verghese Kurien Institute of Dairy and Food Technology, KVASU, Mannuthy, Thrissur*
2. *Sri. C. Achutha Menon Government College, Kuttanellur, Thrissur, Kerala, India*
3. *College of Veterinary and Animal Sciences, KVASU, Mannuthy, Thrissur, Kerala, India*
4. *Vaidyaratnam Ayurveda Research Institute, Thaikkattusseri, Thrissur*

**Corresponding author: kbdivya2002@kvasu.ac.in, Ph. +919495796738*

There are many traditional food knowledge (TFK) associated with this product. *Kaalan* is traditionally recommended to be consumed towards the end of *sadya* and is believed to have a cleansing effect in the gastrointestinal tract. This effect is attributed to its high fibre content derived from vegetables and fenugreek, combined with metabolites from fermented buttermilk, a major element in its preparation. However, these claims regarding the specific functional compounds lack validation. *Kaalan* is a delicious dish, but the present generation is reluctant to prepare it due to the lengthy preparation process and lack of knowledge about it (Aneena, 2009). The absence of documented data regarding its quality aspects, characteristics and standard preparation methods as well as its purported health benefits emphasises the need for further studies. Such investigations may elevate *kaalan* from a mere side dish to a functional food of great appeal.

Non-nutritional elements such as dietary fibre and phytochemicals are increasingly being identified to play a pivotal role in balanced diet. Dietary fibres, partially digested in the human intestine, foster digestive health by preventing constipation and promoting regular bowel movements. They aid in weight management by inducing satiety and reducing overall calorie intake, regulate blood sugar levels, mitigate the risk of heart disease and enhance gut health by nourishing beneficial gut bacteria (Barber *et al*., 2020).

Plants offer an array of phytochemicals, including polyphenols like phenolic acids and flavonoids, celebrated for their potent antioxidant properties. These compounds, abundantly present in fruits, vegetables, and spices, contribute to the defense mechanisms against environmental stressors (Embuscado, 2015). The presence of antioxidants in our diet is crucial in neutralising free radicals, thus preventing oxidative stress linked to various diseases (Valko *et al*., 2007). Flavonoids, a subclass of polyphenols, known for their anti-inflammatory and antioxidant effects, are found in fruits, vegetables, and spices. Turmeric (*Curcuma longa*) contains curcumin, a compound possessing anti-inflammatory, antioxidant, antibacterial, antifungal, antithrombotic, anti-carcinogenic, neuroprotective and cardio-protective properties (Khajehdehi, 2012). Nevertheless, integrating it into food matrices presents challenges due to its limited water solubility and very poor chemical stability. Researchers reported that the presence of piperine in pepper increased the bioavailability of curcumin in turmeric by 154 per cent in rats and 2000 per cent in human volunteers (Shoba *et al*., 1998). Patil *et al*. (2016) demonstrated the mechanism by which piperine increased the bioavailability of curcumin through molecular docking studies. Phospholipids have been successfully utilised for the encapsulation and delivery of curcumin (Jin *et al*., 2016). The consumption of EFY, a major vegetable used in the preparation of *kaalan*, poses challenges due to its acridity and high oxalate content. Calcium oxalate is considered an anti-nutritional compound due to its tendency to hinder the absorption of certain nutrients, affecting the bioavailability of minerals in the diet. Oxalate present in fine crystals in EFY contributes to kidney stone formation and diminishes mineral bioavailability, especially critical for women requiring higher calcium intake. Therefore, an attempt was made to determine the functional components such as dietary fibre and phytochemicals in the traditional product, *kaalan*.

Materials and methods

Preparation of sample

The *kaalan* samples were prepared using the optimised method described by as given in Fig. 1. The samples were ground in mixer grinder, freeze-dried (Operon, Korea) at -70 °C to a final moisture content of less than two per cent and stored in the refrigerator until analysis. Total Dietary Fiber Assay Kit (TDF-100A) and the standards such as gallic acid, catechin and curcumin were purchased from Sigma Aldrich Inc, USA. All other chemicals used in the investigation were of analytical grade and purchased from authorised dealers.

Determination of total dietary fibre

The total dietary fibre in the vegetables was determined using 'Total Dietary Fiber Assay Kit' supplied by Sigma Aldrich Inc. (TDF-100A).

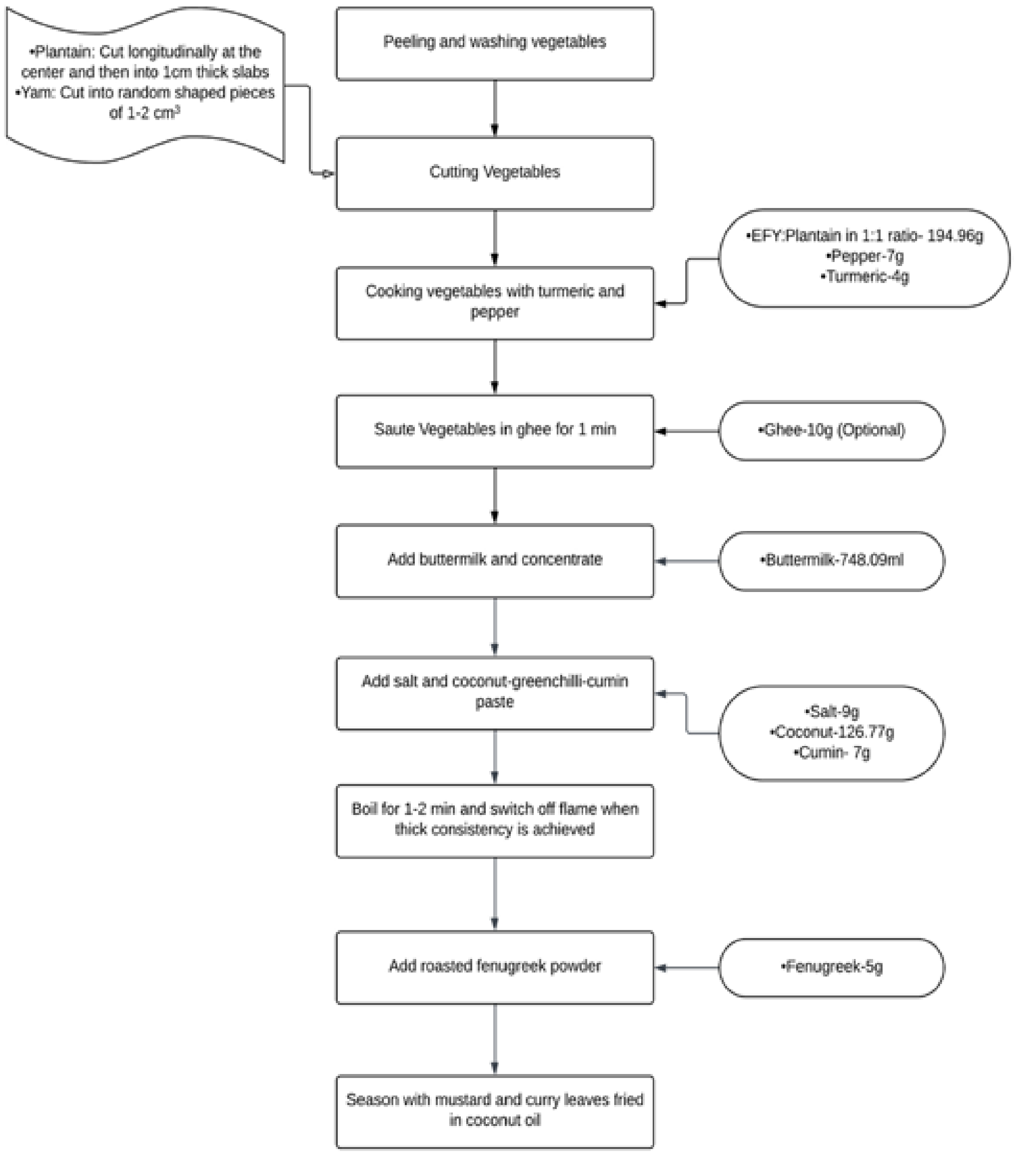

Fig. 1. Flow chart for preparation of *kaalan* **(**Divya *et al.*, 2024)

The analysis of total dietary fibre content uses a combination of enzymatic and gravimetric methods which is based on AOAC (1997). The principle involves gelatinisation of samples with heat-stable α-amylase and enzymatic digestion with protease and amyloglucosidase to remove the protein and starch present in the sample. Ethanol precipitates the soluble dietary fibre. The filtered residue is washed with ethanol and acetone and weighed after drying. Half of the residue was analysed for protein and the other half for ash. Total dietary fibre is the weight of the residue after deducting the weight of protein and ash.

Determination of phytochemicals

The total polyphenol content was determined using the Folin Ciocalteu (FC) method as described by Singleton *et al.* (1999). The absorbance was read at 760nm after two hours using a spectrophotometer (Perkin Elmer, USA). The concentration was determined using a calibration curve, $y = 0.0106x + .0141$ $y = 0.0106x + .0141$ (R^2 = 0.999) prepared using gallic acid as the reference (0-100 mgmL^{-1}) and the results were expressed in Gallic Acid Equivalent (GAE)/g sample. The flavonoid content was determined by using a colorimetric method described previously (Chia-Chi *et al*., 2002; Dewanto *et al*., 2002). Catechin was used as a standard for the determination of flavonoids ($y = 0.003x - 0.2302$, R^2=0.9934). The results were expressed as milligrams of catechin equivalents per gram of sample. Curcumin content in the samples was estimated following the ASTA (American Spice Trade Association) method of 1985 with slight modifications as described by Maurya *et al*. (2020). The results were expressed as ppm of curcumin. A calibration curve, $y = 0.1667x + 0.05.72$ $y = 0.1667x + 0.05.72$ (R^2 = 0.997) was prepared using standard curcumin (Sigma Aldrich, USA).Antioxidant activity was measured using DPPH (2, 2-diphenyl1-picryl hydrazylradical) assay as suggested by Mishra *et al*. (2012). The gallic acid was found to exhibit the highest antioxidant capacity among various polyphenols. Therefore, DPPH radical scavenging activity of the sample was expressed as Gallic acid equivalent antioxidant capacity (GEAC). Determination of calcium oxalate was carried out employing a titration method at three principal stages, namely digestion, oxalate precipitation, and permanganate titration, as outlined by Ukpabi and Ejidoh (1989) and modified by Srikanth *et al*. (2019).

Results and discussion

The functional properties of optimised *kaalan* are presented in Table. 1. It had high amount of dietary fibre, total polyphenols, curcumin, flavonoid and anti-oxidant properties.

Numerous authors have explored the addition of dietary fibre to improve the functionality of food. Chattopadhyay *et al*. (2009) also reported that EFY is a good source of fibre. It was observed that the dietary fibre content of EFY in the current study was 32.03 per cent on dry matter basis which could be a major contributor of dietary fibre in *kaalan* (4.84±0.0.46) prepared using it.

According to Kulkarni *et al*. (2008) plant polyphenols and their secondary metabolites exhibited a wide array of biological functions such as anti-oxidant and anti-inflammatory properties. A systematic review by Del Bo *et al*. (2019) investigated the impact of polyphenol intake on the reduced risk of chronic diseases. The total polyphenol content (TPC) of *kaalan* in the current study was 14.747±0.04 mg GAE/g of sample. Several researchers have explored the possibility of incorporation of herbs and spices into fermented foods, remarking a considerable rise in polyphenol content and antioxidant activity (Ajmi *et al*., 2022; Archana *et al*., 2023). Ogunyemi (2021) observed a considerable increase in TPC of yoghurt incorporated with different spices. The values of TPC observed by Ahmad *et al*. (2020) during the incorporation of apple peel extract in yoghurt were from 3.54 to 8.94 mgGAE/g for different treatments. When encapsulated grape seed extract was added to fermented milk the TPC was 83 mg GAE/g

Table 1. Analysis of functional parameters of *kaalan* (on wet basis)

Functional component	Quantity in optimised *kaalan*
Dietary fibre (per cent)	4.84±0.0.46
Total polyphenols (mg GAE/g of sample)	14.747±.043
Flavonoid content (mg CTE/g of sample)	6.703±.023
Curcumin (ppm)	13.63±0.03
Antioxidant activity (Gallic acid equivalent)	4.812±0.025
Calcium oxalate content (mg/g of sample)	14.46±0.49

n=3, Figures are mean ± standard error

(Yadav *et al*., 2018). TPC content in herbal *lassi* fortified with turmeric was quite low as 0.226 mgGAE/g as reported by Maji *et al*. (2018). The total polyphenols detected in the *kaalan* must have arisen mainly from vegetables, spices, buttermilk and coconut. While the polyphenol levels acquired from consuming *kaalan* alone may not meet the daily recommended intake, it can significantly contribute to the overall polyphenol content in one's daily diet and safeguard from several chronic diseases. Flavonoids, secondary metabolites dominant in plants, fruits and seeds, play a pivotal role in defining their colour, fragrance, and flavour attributes. They are also potent anti-oxidant agents (Embuscado, 2015). The flavonoid content of *kaalan* in the current study was 6.703±.023mg CTE/g of sample showing that *kaala*n had a high anti-oxidant capacity. The overall concentration of flavonoids and polyphenols in a food might not completely explain the associated health impacts due to substantial variations in the bioaccessibility and bioavailability of individual phytochemicals and further studies are required to fully elucidate the health benefits of *kaalan*.

In the preparation of *kaalan*, the buttermilk is added to cooked vegetables and concentrated along with turmeric and pepper. Curcumin is a polyphenol from turmeric which has high antioxidant potential and associated health benefits. It was observed that *kaalan* contains high curcumin content and antioxidant properties. Polovka and Suhaj (2010) in their review, summarised that heat treatment may adversely affect the composition and antioxidant activity of functional ingredients. However, in *Kaalan*, even after high heat treatment, it was found to retain high antioxidant activity. The encapsulating effect of phospholipids and bio-enhancing properties of pepper might have an important role in improving the bioavailability of curcumin after digestion. However, this result cannot guarantee the bioaccessibility of this functional agent in our body due to its high degradability. Therefore, further *in-vitro* and *in-vivo* gastrointestinal digestion studies are warranted for the validation of this claim.

The quantity of calcium oxalate in raw elephant foot yam was 44.71±0.28mg/ g. In *kaalan* the oxalate content was reduced to a safe limit.In Ayurveda, there is a practice of soaking raw wild yam in buttermilk to mitigate its acridity, primarily attributed to oxalate content. The preparation of *kaalan* involves boiling vegetables in buttermilk for a prolonged time, effectively diminishing the calcium oxalate levels. It was found that the calcium oxalate content in the *kaalan* was too insignificant to impact health, compared to reported values (Holloway *et al*., 1989; Singh *et al*., 2018).

Conclusion

Kaalan was found to have a high amount of dietary fibre, and phytochemicals like polyphenols, flavonoid and curcumin content and antioxidant activity which made the product functionally superior. Calcium oxalate content was very low to form any adverse health effects. In conclusion, the research underscores the potential transformation of *kaalan* from a culinary delight to a functional food of considerable health benefits. Its rich dietary fibre content and abundant phytochemicals position *kaalan* as a promising addition to a health-conscious diet, necessitating further investigation to elucidate its comprehensive health impacts.

Acknowledgments

The authors are thankful to the Kerala Veterinary and Animal Sciences University, Pookode, Kerala for providing all necessary facilities and financial support for the research.

Conflict of interest

The authors report no conflict of interest

References

Ahmad, I., Khalique, A., Shahid, M.Q., Rashid, A.A., Faiz, F., Ikram, M.A., Ahmed, S., Imran, M., Khan, M.A., Nadeem, M., Afzal, M.I., Umer, M., Imdad, K., Shahbaz, M. and Rasool, B. 2020. Studying the influence of apple peel polyphenol extract fortification on the characteristics of probiotic yoghurt. *Plants.* **9**: 77.

Ajmi, S. S., Rajakumar, S. N., Divya, K. B., Aysha, C. H. and Aparna, S. V. 2022. Study on effect of refrigerated storage on physicochemical, microbiological and sensory attributes of lutein incorporated calcium and vitamin D fortified Shrikhand. *J. Vet. Anim. Sci.***53**: 356-362.

Aneena, E. R. 2009. Documentation and quality evaluation of selected traditional foods of central zone of Kerala. *PhD Thesis*. Kerala Agricultural University, Vellanikkara, Thrissur.

AOAC. 1997. Official Methods of Analytical Chemist. In *Assoc. of Official Anal. Chem.*pp.**15**.

Archana, S., Divya, K. B., Rajakumar, S. N. and Babu, P. S. 2023. Development and characterisation of yoghurt incorporated with dates (*PhoenixDactylifer*a Linn) extract. *Indian J. Dairy Sci.***76**: 114–120.

Barber, T.M., Kabisch, S., Pfeiffer, A.F.H. and Weickert, M.O. 2020. The health benefits of dietary fibre. *Nutrients.* **12**: 3209.

Chattopadhyay, A., Saha, B., Pal, S., Bhattacharya, A. and Sen, H. 2009. Quantitative and qualitative qspects of elephant foot yam. *Int. J. Veg. Sci.***16**: 73–84.

Chia-Chi, C., Ming-Hua, Y., Hwei-Mei, W. and Jiing-Chuan, C. 2002. Estimation of total flavonoid content in propolis by two complementary colometric methods. *J Food Drug Anal*.**10**: 178-182.

Del Bo, C., Bernardi, S., Marino, M., Porrini, M., Tucci, M., Guglielmetti, S., Cherubini, A., Carrieri, B., Kirkup, B., Kroon, P., Zamora-Ros, R., Liberona, N. H., Andres-Lacueva, C. and Riso, P. 2019. Systematic review on polyphenol intake and health outcomes: Is there sufficient evidence to define a health-promoting polyphenol-rich dietary pattern? *Nutrients.* **11**: 1355.

Dewanto, V., Xianzhong, W., Adom, K.K. and Liu, R.H. 2002. Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. *J Agric Food Chem*.**50**: 3010–3014.

Divya, K.B., Sujith, P., Rajakumar, S.N., Beena, A.K., Divya, M.P. and Ramnath, V. 2024. Physico-chemical properties of optimized *Kaalan-A* traditional dairy product: Optimization of Kaalan. *Indian J. Dairy Sci.* **77**(1):30-39

Embuscado, M.E. 2015. Spices and herbs: Natural sources of antioxidants - A mini review. *J.Funct. Foods*. **18**: 811-819.

Holloway, W.D., Argall, M E., Jealous, W.T., Lee, J.A. and Bradbury, J.H. 1989. Organic acids and calcium oxalate in tropical root crops. *Arch. Biochem. Biophys.* **37**: 164-170.

Jin, H.H., Lu, Q. and Jiang, J.G. 2016. Curcumin liposomes prepared with milk fat globule membrane phospholipids and soybean lecithin. *J. Dairy Sci.***99**: 1780-1790.

Khajehdehi, P. 2012. Turmeric: Reemerging of a neglected Asian traditional remedy. *J. Nephropathol.* **1**: 17-22.

Kulkarni, R., Virkar, A. and D′Mello, P. 2008. Antioxidant and anti-inflammatory activity of *Vitex negundo*. *Indian J. Pharm. Sci*.**70**: 838.

Maji, S., Ray, P.R., Ghatak, P.K. and Chakraborty, C. 2018. Total phenolic content (TPC) and quality of herbal *lassi* fortified with Turmeric (*Curcuma longa*) extract. *Asian J. Dairy Food Res.* **14**: 400-406.

Maurya, N., Khamrui, K., and Prasad, W. 2020. Preparation and Stability Evaluation of Curcumin Fortified Lassi, a Fermented Dairy Beverage. *Intl. J. Ferment. Food*.**9**: 19–30.

Mishra, K., Ojha, H., and Chaudhury, N.K. 2012. Estimation of antiradical properties of antioxidants using DPPH- assay: A critical review and results. *Food Chem.***130**: 1036–1043.

Ogunyemi, O., Gyebi, G., Shaibu, R., Fabusiwa, M., and Olaiya, C. 2021. Antioxidant, nutritional, and physicochemical quality of yoghurt produced from a milk-based fermentation mix enhanced with food spices. *Croatian J. Food Sci. Tech.***13.**https://doi.org/10.17508/cjfst.2021.13.2.10

Patil, V. M., Das, S., and Balasubramanian, K. 2016. Quantum chemical and docking insights into bioavailability enhancement of curcumin by piperine in pepper. *J. Phys. Chem. A*. **120**: 3643–3653.

Polovka, M. and Suhaj, M. 2010. The effect of irradiation and heat treatment on composition and antioxidant properties of culinary herbs and spices -a review. *Food Rev. Int.* **26**: 138-161

Shoba, G., Joy, D., Joseph, T., Majeed, M., Rajendran, R. and Srinivas, P.S.S R. 1998. Influence of piperine on the pharmacokinetics of curcumin in animals and human volunteers. *Planta Med*. **64**: 353–356.

Singh, A.K., Chaurasiya, A.K., Mitra, S., Amit, C. and Singh, K. 2018. Oxalate content in elephant foot yam (*Amorphophallus paeoniifolius Dennst-Nicolson*) dry and fry cubes. *J. Pharmacog. Phytochem.* **7**: 206-211.

Singleton, V.L., Orthofer, R. and Lamuela-Raventós, R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-ciocalteu reagent. *Methods Enzymol*. **299**:152-178.

Srikanth, K.S., Sharanagat, V.S., Kumar, Y., Bhadra, R., Singh, L., Nema, P.K. and Kumar, V. 2019. Convective drying and quality attributes of elephant foot yam (*Amorphophallus paeoniifolius*). *Lwt.* **99**: 8–16.

Valko, M., Leibfritz, D., Moncol, J., Cronin, M.T.D., Mazur, M. and Telser, J. 2007. Free radicals and antioxidants in normal physiological functions and human disease. *Int. J. Biochem. Cell Biol*.[online] **39**. Available: https://doi.org/10.1016/j.biocel.2006.07.001

Yadav, K., Bajaj, R.K., Mandal, S., Saha, P. and Mann, B. 2018. Evaluation of total phenol content and antioxidant properties of encapsulated grape seed extract in yoghurt. *Int. J. Dairy Technol*. **71**:96-104

■